PARK SCIENCE

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Neotropical Migratory Bird Workshop and Research

By Ralph Grundel and Theodore R.Simons

A National Workshop on the Status and Management of Neotropical Migratory Birds was held in September 1992 at Estes Park, CO.

The Proceedings, recently published and available from the USFS Rocky Mountain Forest and Range Experiment Station, (Gen. Tech. Report RM-229) covers issues that are central to Neotropical migratory bird conservation:

Which avian species currently are in decline in North America?

Are there commonalities in biogeography or behavior that link, in a unique manner, species that are in decline?

Are declines most closely related to problems originating during the breeding season, the migratory passage, or on the wintering grounds?

Which monitoring protocols provide the most useful data on the status of avian populations?

What solutions can researchers and resource managers devise for preventing population declines or for augmenting threatened populations?

The workshop was organized under auspices of Partners in Flight, a cooperative agreement between governmental and non-governmental (NGO) organizations intended to facilitate the study and management of Neotropical migratory bird populations. The NPS is one of 14 federal agencies represented on the Neotropical Migratory Bird Conservation Committee, the federal government's component of the Partners in Flight program.

Populations Status: Trends and Monitoring Methodology

The methodology for evaluating the status of breeding birds is evolving to improve the statistical validity of population estimates. Also, studies of breeding bird population dynamics are striving to gather information beyond simple abundance of birds. These procedural changes should improve significantly the usefulness of such data for conservation.

Since 1966, the primary source of information on trends in breeding bird populations in the U.S. and Canada has been the North American Breeding Bird Survey (BBS). The BBS now is coordinated by the National Biological Survey (NBS) in the U.S. The BBS relies on roadside counts of breeding birds, conducted throughout the country. Inadequacies of this methodology were noted

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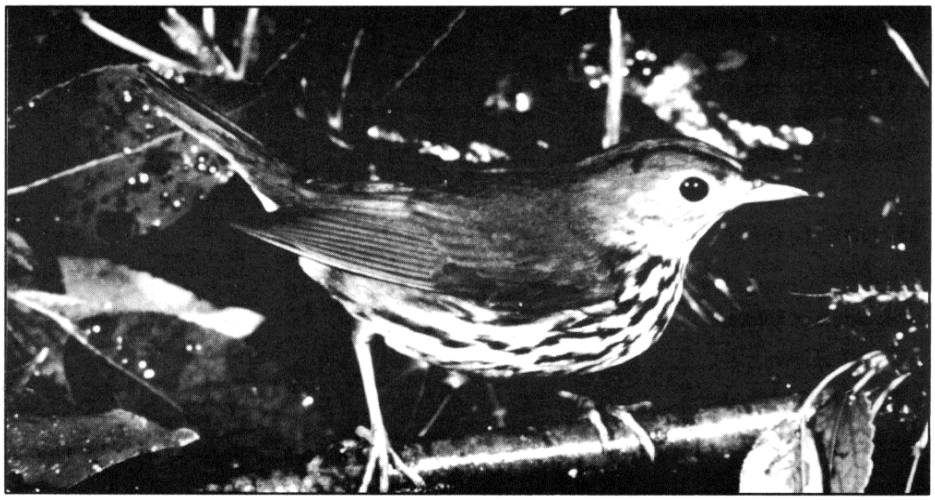
Breeding Bird Survey (BBS) data indicate that Ovenbird (below) populations increased nationwide from 1966-1977, but significantly declined therafter. These changes are regional—Ovenbird populations in the Northeast increased during the 1980s perhaps due to forest maturation. This illustrates the complexity of population trends and the importance of multiple types of census stations. Many warbler species, such as the female Black-throated Green Warbler (above), have experienced especially large population declines according to the BBS, over the past decade. (*Photos: NPS, Indiana Dunes NP*)



PARK SCIENCE

NATIONAL PARK SERVICE

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A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management.

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Editorial

It must be true that what you do, you come to love. The wisdom of the ages has it so, and so, I see, it has become with me.

Since the early days of Jack Kennedy and Stewart Udall, when I was a writer of speeches and press releases in the Secretary's Office of Information, I have been drawn ever more deeply to the National Parks...so much so, that after 6 years of writing the Departmental Conservation Yearbooks I was lured away from my comfortable GS-15 position by NPS Director George B. Hartzog, Jr., and have never once looked back.

My initial attraction to the National Park System led to active involvement and eventually to love, with all the anxious concern that inevitably occurs with the full-blowing of that emotion. I have watched the cyclic struggle to define and control the uses and care of that unique set of resources—a natural, cultural, and spiritual asset whose fate today is teetering on the brink between treasure and tragedy.

I have observed and participated in many of the attempts to understand, interpret, and care for this awesome System. These various attempts have both flourished and languished in the short run, but over the long haul they have stubbornly persisted—even through extended periods of what can only be seen in retrospect as massive ignorance and deliberate destruction.

One of the great joys of recent years has been the sturdy growth of park-based research and science-based resource management. It was a development woefully long in coming and desperately needed. The current well-intentioned effort to strengthen science-based decision-making across the board at Interior has launched--not for the first time (see page 21 for Gerry Wright's review) a consolidated science effort. That effort, once again entitled National Biological Survey, has a chance this time of fulfilling its bright promise without undermining the NPS science program.

But this re-formation of Interior's science program must not be allowed to focus rigidly on "pure" science as opposed to applied research that responds in a timely manner to the crying needs of a System under incredible pressures.

The NPS scientific research program grew out of a desire to understand and document the National Park System's priceless resources and to apply the results of research to the needs of enlightened management. The Park System can profit from the added light that a consolidated cadre of scientists can throw on its makeup. But the feedback into the System from the results of such research must continue as strong support of System management.

No matter how lofty the aim or how high-minded the instigators of the NBS, the National Park System--vulnerable and irreplaceable--must not be allowed to lose its science support, its access to informed input into management decision-making.

As the only editor of this bulletin, which I started 14 years ago, I have tried always to maintain a positive attitude, reporting on the hopeful signs and celebrating news of promising trends. But as I prepare to depart, I have asked myself if I want to be remembered (if at all) as Pollyanna, or would I rather sound the warning note that more faithfully reflects anxieties lying not far below surface bravado. I came to the conclusion that I could not go without one word of caution.

Looking back can be as important as looking to the future. Regrettable events that have happened in the past should be faced, recognized, and not allowed to overtake us again. Once, we lost our way. It happens. But twice? Please, not again!

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at the conference. For example, the BBS emphasizes species readily seen or heard from roadsides and active during early morning. Also, BBS data provide limited clues to causes of documented declines. Still, BBS data do inform us of changes in relative abundance of many species over many years.

BBS data suggest that population trends from 1982-1991 for many species were different from the overall trends noted for the 1966-1991 span of currently analyzed BBS data. A statistically significant proportion of Neotropical migratory species in the U.S. (61%), exhibited declines in breeding season numbers during the 1982-1991 period. Over the entire 1966-1991 period however, there was not a statistically significant percentage of species exhibiting declines. Thus, a significantly increased rate of decline seems to have occurred in the decade from 1982-1991.

Nationwide BBS analyses show that population trends for species often are regionally and topographically specific, so that a species declining in one biogeographic province might not be declining elsewhere. Only through a large network of monitoring stations is it possible to document this type of variability and establish the true current status of a particular species.

Areas that are experiencing relatively little human modification to the landscape are especially important stations within a monitoring network. This critical role is one the national parks are uniquely suited to perform. In addition, the national parks can inform the public of within-park trends in breeding bird numbers and how these trends relate to global changes in bird populations.

One frequently raised point at the meeting was the need for additional monitoring programs to collect data on avian breeding productivity. David DeSante, of The Institute for Bird Populations in Point Reyes, CA, gave an overview of the MAPS (Monitoring Avian Productivity and Survivorship) program, which is attempting to obtain such demographic data at stations throughout the country. Many of the MAPS stations are on federal lands. Programs that count the number of breeding adult birds in an area but do not document productivity, or how many new birds are hatched and fledged, can present a misleading assessment of the habitat's ability to support breeding birds.

The quality of the breeding habitat should instead be assessed by asking whether the number of young birds produced is sufficient to compensate for adult mortality throughout the year; in other words does that habitat

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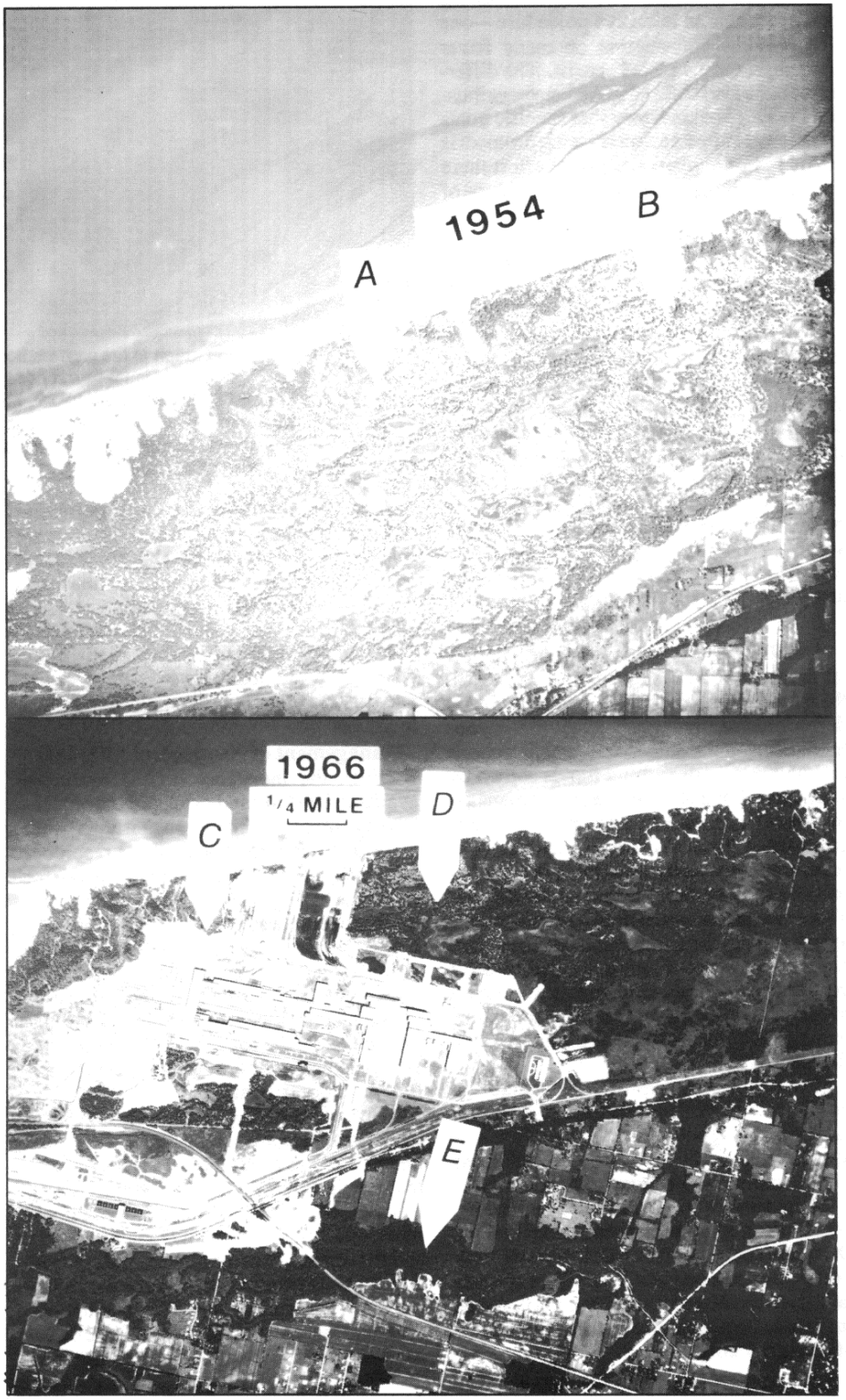
The habitat fragmentation that negatively affects many breeding bird populations is strikingly illustrated here. A, from 1954, and C, from 1966, point to the same location just outside the boundary of Indiana Dunes National Lakeshore; B & D are just inside the park's boundary. Intensive commercial development (c) of dune ecosystem, from 1954 to the time of the park's formation in 1966 increased insularity of the park. Insularity often negatively affects animal and plant populations. Riparian corridor section of the park (E) is separated from body of the park by farm and residential land.



produce enough birds annually to sustain population levels? Monitoring nest success directly, by nest inspections or by mist netting birds to count the fledglings produced, improves our understanding of habitat breeding suitability. This is one goal of the MAPS program.

It should be noted here that monitoring nest success is an intensive procedure—one that provides information on many fewer species than does a BBS census. The differences between BBS and MAPS surveys illustrate why it is mandatory that specific goals be delineated before a monitoring protocol is chosen. For a given amount of effort there always will be a tradeoff between the scope of the survey and the detail of the information gathered.

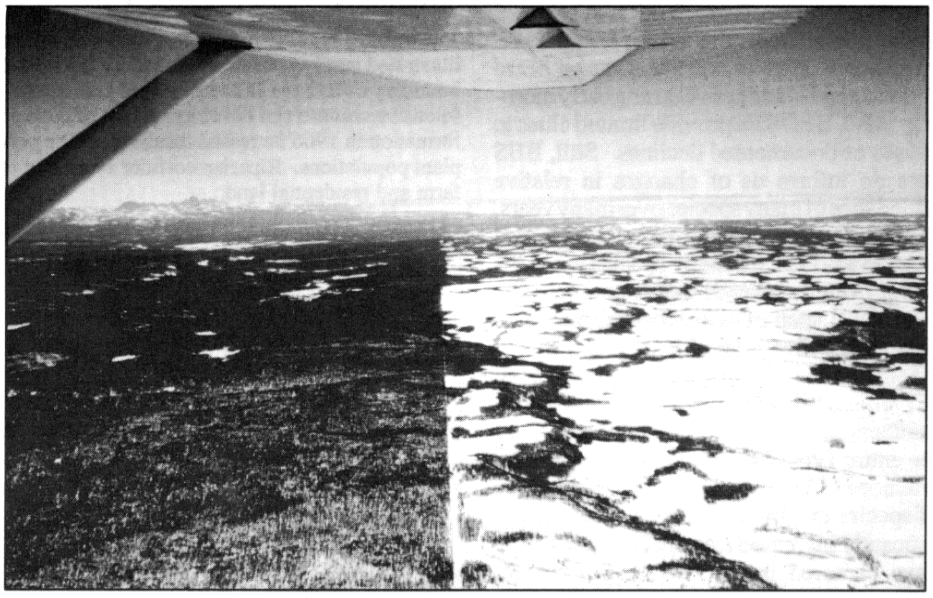
BBS and MAPS type surveys are parts of a comprehensive program. For example, within a park it often will be most useful to proceed from more general to more specific monitoring programs and to be cognizant of the types of conclusions that can be drawn from each program's data. Most parks will want first to produce a checklist of birds so that researchers and resource managers are aware of what species are present. Additional information on relative population trends might be established by a BBS type survey, and those trends might be better understood by undertaking a MAPS type study of several species.

Goals for Management

Sam Droege urged those considering establishment of a monitoring program to ask the specific purpose of the program. Can you define management goals that will use your monitoring data and management actions that will rectify disturbing trends shown by your data? For example, is a park's management goal to ensure that no species experiences more than a 50 percent decline over time, or that a minimum of 100 breeding pairs of a particular species is maintained? These two questions require different monitoring approaches, although both require high intensity monitoring, probably on a yearly basis. On the other hand, less accuracy might be required in evaluating more common species, which might be monitored on a five year cycle.

If no management options are available to influence a declining population, then you cannot expect good population news to follow bad monitoring news, and the usefulness of your monitoring program is undermined.

Make sure your monitoring program fits within your long-term monitoring budget, Droege urged. Try to standardize your monitoring protocols so your data will be comparable to data collected by other studies, and be sure to evaluate periodically the effectiveness of your protocols.



Wintertime aerial photograph at the western border of Yellowstone NP. Park occupies left half of the picture, Targhee National Forest occupies right Half. Clearcut areas of the National Forest clearly contrast with the National Park, illustrating the insular character of even large parks. Insularity negatively affects many bird populations. Parks can serve as control areas for evaluating the impact landscape modification has on birds. (*Photo: Tim Crawford, courtesy of the Greater Yellowstone Coalition.*)

A central event of the meeting was presentation of monitoring goals from both governmental organizations and NGOs. Federal agencies outlining their monitoring and management plans for Neotropical migrants were USFS, USFWS, EPA, BLM, and DOD. (This meeting was held before formation of the National Biological Survey, which today plays a key role in coordinating Neotropical migratory bird research and the BBS.)

Management of Neotropical Migrants

Given the inevitably limited resources available for study and management of Neotropical migrants, many suggestions were made as to how to allocate these resources effectively. Several schemes were given for ranking which species deserve most immediate management attention. William Hunter, David Pashley, and Michael Carter suggested that global abundance, threats on the wintering and summering grounds, size of winter and summer distribution, and population trends are the chief factors, to be considered together, in determining a species' conservation priority rating.

Ways of improving habitat were suggested by Chandler Robbins, John Sauer, and Bruce Peterjohn: For forest birds, maximizing the interior portion of forests and minimizing isolation of forest fragments from one another, encouraging diversity of native plants and the age structure of forests, and controlling exotic vegetation; for field birds, reducing mowing during breeding season, increasing the amount of grasslands that lie more than 100 meters from other habitats, leaving some fields fallow for several years, and preventing overgrazing.

While understanding the dynamics of population numbers is central to establishing the status of Neotropical migrants, conservation and management actions require a thorough knowledge of avian life histories. Russell Greenberg noted the importance of determining what resources migratory birds defend. Such defended resources frequently are unexpected, or at least not apparent to the casual observer, yet they are key to survival of that species. For example, the conservation of trees containing essential food--such as honeydew-secreting scale insects or certain fruits--is a critical concern in the management of wintering grounds for some migrants.

Such biological facts are known in only a small percentage of cases, so basic natural history studies must not be considered as esoteric addenda to practical research but rather as critical elements in conservation management.

The workshop also addressed problems inherent in making land use decisions. Partners in Flight is a cooperative program, dealing with species that require several geographically diverse habitats for yearlong survival. There is great potential here for promoting cooperative management of many habitats, benefitting all landbirds and other biotic resources.

Cooperative land management involves great biological and management complexity. The conference talk that was voted best-

titled on the topic of integrating land management practices for multiple animal species was Ronald Escano's: "You cannot manage for every species on every acre." Marcia Patton-Mallory urged review of research plans by resource managers early in the research planning process. Such early review increases likelihood that the information gathered can be used to make land management decisions. Land management actions are essentially experiments-in-progress, she noted, but they rarely are documented, and the information they yield is not disseminated.

The concluding workshop talks noted the dilemma land managers face in making land use decisions based on scant data, and the tradeoffs that arise in managing for single species versus the multiple species that actually inhabit any plot of land. The use of indicator species, or a guild management approach, have not solved these problems. Large geographic scale approaches to management were stressed, recognizing for instance that a Neotropical migrant might be endangered in lowland portions of its range but not in upland portions, or recognizing that one forest opening can provide feeding opportunities for brown-headed cowbirds, which can then parasitize passerine nests for miles around.

The 1992 workshop represented the third large gathering in the past 15 years of researchers in the field of Neotropical migrant conservation. Since the late 1970s, our understanding of the importance of wintering grounds in maintaining populations has grown greatly. The pendulum has swung to and fro in scientific circles as to the relative roles of changes in wintering, migration, and breeding grounds in avian declines. The participants of this workshop mainly were responsible for researching and managing species outside of wintering grounds, hence the workshop emphasized breeding season effects and effects during migration.

Conceptual advances are being made that improve the data gathered from monitoring. We now recognize that monitoring avian productivity is essential to more effective management. Methods for gathering these data in a statistically valid way are improving. We recognize that more complete natural histories of birds are essential conservation tools. We know that early and continued communication between researchers and resource managers increases the likelihood that research will contribute to more informed management decisions. We recognize too that our ability to understand the often conflicting requirements of co-occurring species is extremely limited. Prioritizing conservation and land management efforts, given that limitation, is one of the leading challenges facing the Partners in Flight coalition.

Table 1. On-going Neotropical migratory bird research and monitoring on NPS lands. This table presents results of an informal survey and of summaries from Investigators Annual Reports. If you know of other such projects being carried out in the national parks, please notify the authors, who are preparing a report on migrant bird research in the parks for the *Partners in Flight* newsletter.

Park	Activity
Acadia	Breeding bird surveys
Apostle Islands	Migration monitoring Breeding bird surveys
Arches	Pinyon/juniper breeding bird research
Bering Land Bridge	Gyrfalcon research
Big Bend	Peregrine Falcon monitoring Black-capped Vireo monitoring Christmas bird counts
Cape Cod	Breeding bird surveys
Channel Islands	Terrestrial bird census
Chiricahua	Resident and migrant bird survey
Craters of the Moon	Breeding bird surveys
Devil's Tower	Breeding bird monitoring
Denali	MAPS station (5)
Everglades	Breeding bird surveys
Fire Island	Pinelands bird community research Migration monitoring
Gateway	Migration monitoring
Glen Canyon	Willow Flycatcher survey
Grand Canyon	Willow Flycatcher survey
Grand Teton	MAPS station (1)
Great Smoky Mountains	Cove hardwood breeding bird community research Wood Thrush population dynamics research Breeding bird surveys
Gulf Islands	Trans-Gulf migrant stopover ecology research Trans-Gulf migrant habitat research
Indiana Dunes	Breeding bird survey, rail survey, nightjar survey, heron survey
Isle Royale	Raptor monitoring
Kubuk Valley	Breeding bird surveys
Lava Beds	Breeding bird surveys
Mount Rainier	Breeding bird surveys
North Cascades	Breeding bird surveys
Ozark Riverways	Swainson's warbler research
Padre Island	Breeding bird surveys Peregrine Falcon monitoring
Point Reyes	MAPS station (1)
Rocky Mountain	Peregrine Falson monitoring
Santa Monica Mountains	Corridor bird survey Urban/wildland interface bird survey
Sequoia/Kings Canyon	MAPS station (2)
Shenandoah	MAPS station (6)
Wrangell–St. Elian	Breeding bird surveys
Yosemite	MAPS station (5) Peregrine Falcon monitoring
Yukon Charley	Peregrine Falcon monitoring
Zion	Breeding bird monitoring

The Role of National Parks

A variety of activities taking place in National Parks is contributing to the Partners in Flight program (Table 1). These activities can be as simple as Christmas bird counts or as complex as long-term research and monitoring programs. National Parks are ideal control sites for long-term population monitoring. Monitoring trends on protected habitats in parks can help determine whether changes in Neotropical migrant populations result from changes in habitat conditions on the breeding grounds in North America or from changes to tropical wintering habitats.

The newly formed NBS will be initiating regional scale research and monitoring programs to contribute to the Partners in Flight program. Data from control sites on NPS lands will make a valuable contribution to those efforts.

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Minor Violations, Major Damage: A Survey of Noncompliant Visitor Behavior and Managerial Practices

Darryll R. Johnson, June C. Rugh, Mark E. Vande Kamp, Thomas C. Swearingen

A hiker, hot and thirsty, pauses to catch his breath and drink from his canteen. As he looks across the lush subalpine meadow bordering the trail, his eye catches the faint traces of a path cutting through the meadow to the next switchback. Throwing the canteen back in his pack, he starts out across the meadow. "After all," he muses, "I'm not leaving any tracks."

To the typical day hiker, the impact of a few minutes of off-trail hiking in a national park appears negligible, even in a highly sensitive area. Yet it is *minor* rule violations such as these which, according to a system-wide survey conducted by the University of Washington CPSU, cause over 80 million dollars of reparable damage to national park resources every year[1,2]. Minor rule violations are also reported destroying nonreparable resources at about two-thirds of the reporting units, and annual clean-up costs are estimated to be approximately 18 million dollars. In all, *noncompliant visitor behavior* (see **Glossary of Terms**) emerges as a costly, system-wide problem which resource managers cannot afford to ignore.

The fact that the growth rate of national park use in the United States has exceeded the national population growth rate over the past two decades makes the magnitude of the problem even clearer. As host to 273 million recreational visitors in 1993, the National Park Service (NPS) encourages visitors to enjoy park resources. However, high visitation rates pose a challenge for resource managers, who must balance visitor enjoyment with the agency mandate of preserving park resources. In addition to documenting the magnitude and type of resource impacts due to noncompliance and specifying which of 20 explicitly defined types of noncompliant behavior are responsible for the damage, this survey also explored current managerial practices for preventing such damage in national parks, including managers' perceptions of the effectiveness and appropriateness of specific *noncompliance deterrence techniques* (see **Glossary of Terms**).

In describing damage to natural and cultural resources caused by noncompliant behavior, respondents answered in terms of 16 types of sites (10 frontcountry and 6 backcountry sites[3]) and gave both cost estimates for repairs and annual costs for recurring problems such as litter. Eighty-nine percent of the units reported reparable damage at frontcountry sites, with developed visitor sites most frequently reported as damaged, followed by frontcountry historic sites and picnic areas. Repair cost estimates concerning damage to historic sites totaled 32.3 million dollars; for all frontcountry sites reported, the repair cost estimate reached 66.3 million dollars. Of the units having backcountry, 87% reported reparable damage at some type of site, with damage to hiking and stock trails totaling about 4.6 million dollars and repairs for all backcountry sites reaching 13.7 million dollars for estimated repair costs and recurring annual costs of clean-up in frontcountry and backcountry sites). Overall, historical sites were most often reported as the most damaged type of site, followed by developed visitor sites[4], archaeological/paleontological sites, accessible natural attractions, and campgrounds and picnic areas.

The high figures for repair and annual clean-up costs are sobering. However, due to the NPS mandate of resource preservation, the extent to which noncompliant visitor behavior impacts *nonreparable or nonrenewable resources* is an even more serious matter for park managers. Of all reporting units, 72% reported damage to nonreparable resources. Nonreparable damage was reported at frontcountry sites in 68% of reporting units and 71% of units with backcountry reported nonreparable damage in those areas. Archeological, paleontological, and historical sites are most often reported as having nonreparable damage. Managers' comments from the survey offer illustrative examples of the consequences of such damage:

If falcons do not successfully nest—this is irreparable for the year, and they may not return the following year—a potentially nonrenewable resource.

Totem poles are nonrenewable resources in the sense that they are cultural objects and are unique. While new or reproduction poles can be carved, these are not the same.

Cryptobiotic crust and plants are renewable, but so slow-growing that if destroyed or continually disturbed they may not return—or it may take decades.

Constant touching and rubbing of historic cannon wears away the carved/cast features, particularly when multiplied by 600,000 - 800,000 persons a year. Unlike, say, Civil War cannons, these 200+-year-old Spanish cannons are extremely rare.

Respondents were also asked to identify the noncompliant visitor behaviors they considered the most destructive at each type of site for which any degree of damage was reported. For all sites, littering is the highest-ranked damaging behavior, followed by damaging the built environment, damaging or defacing cultural or historical objects, collecting paleontological or cultural objects as souvenirs, and off-trail hiking. For backcountry sites, the highest-ranked damaging behavior is collecting paleontological or cultural objects, followed closely by littering and off-trail hiking.

Regarding visitor management strategies, the responding units reported the use of a variety of methods for controlling noncompliant behavior, ranging from brochures and informal personal contact to barriers and direct enforcement. However, although almost all units try to prevent noncompliance, managers estimated that these efforts deter only about 60% of such behavior in the frontcountry and 52% in the backcountry. Clearly, a substantial amount of damage caused by noncompliant visitor behavior—to both reparable and nonreparable resources—is undeterred by current control methods. If unchecked, this damage will reach crisis proportions in some units during the next century.

Compounding this problem is the apparent widespread disagreement among resource managers concerning philosophically acceptable and practically effective means of deterrence. Survey results showed a striking disparity among respondents when they were

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[1] The survey employed an extensive questionnaire addressed to all NPS administrative units. The superintendent of each NPS field unit was contacted by phone and asked to recommend a staff person from the unit most qualified to complete the questionnaire. The questionnaire was sent directly to this person, except in cases where the superintendent asked to examine the questionnaire first, and then passed it on to the staff person. The questionnaires were mailed in March 1992 and garnered a response rate of 82%. The research was supported by the Office of the Associate Director of Natural Resource Management of the National Park Service with the Natural Resource Preservation Program (NRPP) Special Initiative funding.

[2] This survey has several limitations that should be kept in mind. Although we asked that the most knowledgeable person in the park complete the questionnaire, the extent to which respondents had accurate and complete knowledge of damage and the cost to repair or maintain resources is unknown. The costs reported here for repair and maintenance of NPS resources being damaged by noncompliance were estimated by assuming that the rates of damage in nonresponding units occur at the same level as in responding units. Finally, the attitudes of respondents toward the effectiveness and appropriateness of various deterrent strategies represent the population of people chosen by the unit's superintendent to complete the questionnaire. The extent to which these attitudes are congruent with other people in park management positions is unknown.

[3] **Frontcountry**: Areas not designated backcountry and wilderness, and areas of backcountry and wilderness easily accessible to day-hikers.

Backcountry: Areas designated as backcountry or wilderness that are not easily accessible to day-hikers.

asked to consider the appropriateness and effectiveness of a variety of deterrence techniques in a hypothetical frontcountry subalpine setting, "Magnificent Meadows." (This hypothetical scenario was used to ensure that respondents answered questions concerning the use of deterrence techniques under identical conditions and assumptions.) When asked to rate informal personal contact in terms of *effectiveness* (see definition in **Glossary of Terms**) as a control strategy, for example, similar proportions of respondents rated this technique as 80% effective (highly effective) and 20% effective (minimally effective).

When respondents were asked to consider the *appropriateness* (see **Glossary of Terms**) of specific deterrence techniques, similar discrepancies surfaced. Given the context of NPS's explicit mandate of management for visitor enjoyment, 43% of responding managers believed that threats of citations or fines were inappropriate. Yet 17% of respondents chose threats of fines and citations as the best deterrence technique for use in Magnificent Meadows.

This lack of consensus concerning both effectiveness and appropriateness of visitor management strategies underscores the fact that little scientific knowledge is available to guide NPS resource managers in making decisions about deterring the noncompliance. Coupled with the magnitude of the problem, this fact indicates that the first step urgently needed for a coordinated approach to visitor control strategies is the establishment of an institutionally distributed database dealing directly with appropriate and effective means of deterring such behavior. Next, there must be an organizational agreement on acceptable means and strategies. This agreement will be reached only if accompanied by research in the national parks which examines the relationship between various deterrent approaches and the quality of visitor experiences. Finally, in order to make concrete recommendations for holistic visitor management strategies throughout the national park system, in-house research and a technology transfer program would be essential.

Although it would be unrealistic to hope that all damage-producing noncompliance could be prevented, related research at Mount Rainier National Park[5] and the accompanying literature review suggest that a well-coordinated program of research and information dissemination to park staff dealing with noncompliant behavior, coupled with the willingness of managers to act, would significantly reduce the incidence of resource damage. In fact, this problem represents an excellent opportunity for leadership on the part of both the NPS and the National Biological Survey (NBS). Specifically, appropriate divisions of these agencies could plan and fund a coordinated research program designed to provide system-wide guidelines for the deterrence of damaging noncompliant visitor behavior and, in turn, establish an information dissemination program to promote the use of this information. Considering the magnitude of repair and clean-up costs necessitated by ongoing noncompliance, such a research program would offer a highly favorable cost-benefit return. And visitors to the national parks would be spared the unfortunate irony of destroying the resources they hope to enjoy.

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GLOSSARY OF TERMS:

Noncompliance [Noncompliant Visitor Behavior]—Minor rule-breaking behavior or failures to comply with minimum impact regulations (e.g., off-trail hiking, souvenir collecting, feeding wild animals, littering). This definition excludes major acts of vandalism and acts motivated by obvious criminal intent.

Deterrence: The act of preventing noncompliance. Managers who seek to deter noncompliance are trying to get visitors to follow the rules (and refrain from breaking the rules).

Deterrence technique: A method of deterring noncompliance (e.g., educational programs, regulatory signs, threats of fines).

Effectiveness: Defined here as the percentage of noncompliant behavior that would be deterred if the indicated means of control were adopted.

Appropriateness: Defined here as the extent to which a means of control is acceptable, given the broad philosophical principles concerning park management and the specific NPS mandate of management for visitor enjoyment.

The following publications are available from the NBS CPSU, AR-10, U/WA, Seattle, WA 98195:

Johnson, Darryll R. and Thomas C. Swearingen. 1988. *Minor rule violators: A profile of off-trail hikers, Paradise Meadows, Mount Rainier National Park.* NPS CPSU, College of Forest Resources, University of Washington, Seattle.

Johnson, Darryll R. and Thomas C. Swearingen. 1992. *The effectiveness of selected trailside sign tests in deterring off-trail hiking, Paradise meadows, Mount Rainier National Park.* In: C. Christensen and D. Johnson (eds.), Proceedings of the International Symposium on Vandalism: *April 20-22, 1988.* USFS - PNW Forest and Range Experiment Station, Seattle.

Johnson, Darryll R., Mark E. Vande Kamp, and Thomas C. Swearingen. 1994. *A survey of park managers' perceptions of noncompliant visitor behavior causing resource damage in the national park system.* USDI, National Park Service, Technical Report NPS/PNRUW/NRTR-92/07.

Swearingen, Thomas C. and Darryll R. Johnson. 1988. *An analysis of off-trail hiking in response to selected social control techniques at Paradise Meadows, Mount Rainier National Park.* NPS CPSU, College of Forest Resources, University of Washington, Seattle.

Vande Kamp, Mark E., Darryll R. Johnson, and Thomas C. Swearingen. 1994. *Deterring minor acts of noncompliance: A literature review.* USDI, National Park Service, Technical Report NPS/PNRUW/NRTR-92/08.

Yellowstone Fires Of 1988 Told In New Book

A Bibliography and Directory of the Yellowstone Fires of 1988, by D. Despain, J. Greenlee, J. Parminter, and T. Sholly, is an important new tool available for assisting those engaged in fire research. The International Assn. of Wildland Fire announces the second edition of this volume, complete with 1,051 citations and 344 names and addresses of researchers. The index of this 169-page paperback document guides the user to articles of interest, with names, addresses, phone and FAX and e-mail addresses of authors included.

The directory may be had in paperback for $20.19 and in hardcase for $30.19 from the International Assn. of Wildland Fire, P.O. Box 328, Fairfield, WA 99012-0328.

In the next issue...

New *Park Science* Editor, Jeff Selleck, will share his vision for an expanded pool of writers from among NPS resource managers and his criteria, guidelines, and suggestions for new catagories of articles.

Note on page 16 of this issue Rolodex card with new instructions for contacting the editor.

[4] Developed visitor sites are areas characterized by a concentration of visitor services such as restaurants, visitor centers, lodging facilities, etc.

[5] See list of publications at the end of this article.

Preventing Visitor-Caused Damage To National Park

Mark E. Vande Kamp, Darryll R. Johnson, Thomas C. Swearingen

NPS managers require new information if they are to prevent visitors from breaking park rules and damaging park resources. The preceding article described our survey of NPS managers that showed both extensive damage to park resources due to minor acts of noncompliance and a lack of agreement among resource managers concerning the usefulness of various methods used to deter noncompliance. In conjunction with the survey we also reviewed social science literature relevant to the question, "How can NPS managers get visitors to follow park rules?" (i.e., How can managers *deter noncompliance*?) This article summarizes twelve recommendations to NPS managers suggested by the review, and also proposes a research program to develop a complete strategy for deterring noncompliance. (A full report of the review is available from the University of Washington (U/WA) CPSU -- see references)

The literature we reviewed was gathered from several social sciences including sociology, leisure and recreation science, social psychology, and environmental psychology, and fell into many theoretical traditions ranging from applied behavior analysis to sociological deterrence theory. The research could not be integrated into any existing or new theoretical approach. Instead, we searched for general assertions about deterring noncompliance that were relevant to the NPS and were supported by research results. The assertions we found are presented below as twelve recommendations for NPS managers. Let's consider each of these recommendations and their basis in the research.

What We Know

1) In evaluating a deterrence technique (i.e., a method of getting visitors to follow the rules), NPS managers must consider its deterrent effect, its impact on visitor experiences, and the level of noncompliance that is acceptable in their units. If resource preservation were the only requirement of NPS managers, there would be no noncompliance problems. Managers could fence in visitors, institute prison sentences for noncompliance, or simply exclude visitors entirely. However, the dual mandate of the NPS specifies that the national parks should be managed so as to both maximize visitor enjoyment and preserve park resources for future enjoyment. The delicate balance between these mandated goals is inextricably linked with decisions concerning noncompliance. For example, in an NPS unit where moderate levels of noncompliance produce acceptable levels of resource damage, a deterrence technique that achieved such moderate levels would be preferable to a more effective technique that had greater negative impacts on visitor experiences.

2) Multiple deterrence techniques should be used when attempting to deter noncompliance because no single technique is likely to deter all forms of noncompliance, or even to counteract the many motives for a single form of noncompliance. The diversity of the literature cited in our review suggests that using a single label -- noncompliance -- to describe the huge set of behaviors that are against some rule in a given environment conveys a false sense of simplicity. Noncompliance is even more complex because there can be many motives for any given noncompliant act. A single NPS environment may be affected by many noncompliant behaviors, each of which occurs for a number of reasons. Because of this, no single deterrence technique should be expected to deter a major portion of noncompliance, even in a single environment.

3) Decisions about deterrence techniques should not be based solely on the intuitive assessment of NPS managers using their own reactions to the intervention. In scientific terms, each NPS manager constitutes a sample of one person who is unlikely to represent most visitors to their unit. In addition, research from social psychology suggests that managers, like the rest of us, seldom recognize all the factors that actually affect their behavior. Unfortunately, the current literature is usually insufficient to provide managers with scientific evidence on which to base their decisions about deterring noncompliance. In the absence of scientific evidence, manager decisions could be improved if they were to imagine a variety of visitors reacting to deterrence techniques and then select the method appealing to the broadest range of visitors.

4) NPS managers should consider stationing uniformed employees within sight of areas damaged by visitor noncompliance because the presence of such employees is one of the most promising means of deterring noncompliance. Research suggests that the presence of a uniformed employee strengthens visitor beliefs that noncompliance will lead to negative social or legal consequences, even when that employee is not engaging in enforcement activity. The uniformed employee may also remind visitors of their own attitudes or personal norms that are inconsistent with noncompliance. Research conducted by the U/WA CPSU at Mount Rainier National Park showed that uniformed employees were perceived as a neutral or positive part of the park experience by the vast majority of visitors, while simultaneously reducing noncompliance (off-trail hiking) to very low levels (see references).

5) NPS managers should ask, "Why are visitors breaking this rule?" as a first step in controlling noncompliance. If an incentive can be readily removed, noncompliance may drop to acceptable levels. A large body of psychological theory (e.g., applied behavior analysis and utility theory) specifies that people generally act to gain rewards or avoid punishments. Accordingly, removing the reward or punishment that prompts noncompliance may be easier than overcoming its presence. For example, a social trail that cuts a switchback may see less use if thorny native vegetation is planted at its entrance and exit.

6) To maximize effectiveness, messages designed to limit noncompliance should be presented as close as possible to the place and time in which noncompliance is likely to occur. Substantial research (e.g., studies from applied behavior analysis, attitude theory, and investigations of social norms) suggests that messages designed to deter noncompliance are most effective when presented as closely as possible to the place and time in which noncompliance is likely to occur. Signs are generally an effective means of communicating such messages. A study in Mount Rainier National Park conducted by the U/WA CPSU found that sign texts varied greatly in effectiveness, but that all signs placed near social trails deterred significant amounts of off-trail hiking.

7) The current NPS focus on deterring noncompliance by instilling beliefs consistent with compliance should be altered to focus primarily on activating such beliefs in visitors who already have them rather than on converting the unconvinced. A broad range of research (e.g., research on attitude theory and personal norms) has shown that it is difficult to change visitor beliefs. However, related research has also shown that activating existing beliefs can alter behavior. Accordingly, more noncompliance will probably be deterred by erecting several trail-side signs that say, "Help preserve the meadow. Stay on the trail.", than by adding a single visitor-center display describing the unique nature of the meadow.

8) Showing visitors that noncompliant behavior damages NPS resources will only deter noncompliance for visitors who hold strong values inconsistent with such damage. Basic behavioral principles suggest that short-term rewards generally have more control over behavior than long-term negative consequences. For example, many visitors will pick up small bits of rock or vegetation as souvenirs even if they are aware that, in the long-term, such actions cause substantial damage. Knowledge about long-term consequences will deter noncompliance only for visitors who have strong values inconsistent with harming the environment. Because visitors who do not hold such values may be responsible for most noncompliance at some NPS units, control of noncompliance at those

units will require deterrence techniques other than education.

9) Noncompliance can be reduced by removing evidence of prior noncompliance, and by providing evidence that most visitors follow the rules. Research on social norms and related studies of noncompliance suggest that decreasing direct and indirect observation of noncompliance can decrease further noncompliance by observers. For example, several studies have found that littering increases in already-littered environments, and decreases when the environment is cleaned. Also, research by the U/WA CPSU found that off-trail hiking was most likely to occur when visitors were within visual distance of other off-trail hikers. Research on speeding suggests that park noncompliance can also be reduced by providing evidence that most visitors follow the rules. For example, speeding was reduced by signs stating, "Percentage of cars not speeding yesterday: **%", where ** was near 90%.

10) When noncompliance is deterred by threats of punishment, the threats should be accompanied by messages emphasizing visitor benefits from compliance. The U/WA CPSU found that a sign stating, "Off-trail hikers will be fined", was the most effective of several signs used in their study at Mount Rainier National Park. Evidence from social psychology suggests that such a threat of punishment would be most effective and have the least negative impact on visitor experiences when visitors believe that compliance benefits both themselves and NPS managers. Educational programs emphasizing the public benefits of preserving park resources may deter little noncompliance on their own, but may increase the effectiveness and acceptability of threatened punishments.

11) NPS rules can produce a "boomerang effect" of deliberate noncompliance when visitors feel their freedom is threatened. To reduce the probability of such effects visitor options should be emphasized. Reactance theory suggests that when threats of punishment are communicated, messages should emphasize the visitor's freedom to choose ways in which to comply. For example, a regulatory sign might say, "Fine of $100 for off-trail hiking", and then continue, "Because this is a high traffic area, visitors are not allowed to walk off official trails. If you are interested in walking through an alpine meadow you may take hike #12 to Golden Meadow."

12) When NPS communication is addressed to a group, the effectiveness of messages intended to deter noncompliance will be enhanced by special efforts to address the message to group leaders or to address all individuals within the group. Social psychologists have found that persuasive messages are more effective when addressed to individuals than when addressed to groups. A message directed at a group leader who is responsible for the group's behavior is likely to be more effective than a message directed at the whole group. Alternately, NPS agents should design messages so that all group members feel they are being individually addressed.

What Should Be Done

Although the above recommendations represent an advance in the information available to NPS managers concerning the control of visitor noncompliance, they are far from complete. Future research can and should focus on the development of a comprehensive strategy that provides managers at all NPS units with guidelines for deterring noncompliance. Highlighted below are the basic characteristics of a future research program that we propose as a means of developing such a complete strategy.

Characteristics of a future research program aimed at developing effective programs to deter noncompliance in the NPS.

1) Program will test multi-pronged interventions that incorporate multiple deterrence techniques and are designed to influence diverse visitors who break rules for diverse reasons.

2) Both effectiveness of deterrence and impact on visitor experiences will be measured and used in designing and evaluating interventions.

3) Program's primary goal will be the development of two to four multi-pronged interventions that vary simultaneously in deterrence effectiveness and negative impact on visitor experiences. NPS managers could select the intervention offering adequate resource protection with minimal negative impact on visitor experience.

4) Program's secondary goal will be the development of a set of guidelines for designing evaluation research that can accurately determine the effectiveness of an intervention in any specific application.

5) Program will be designed and monitored by a multi-disciplinary panel of scientists.

6) Research will be conducted in a variety of NPS settings representing a wide range of visitor populations and park environments.

Characteristic 1. Because noncompliant behavior is very complex and because current theory and research concerning noncompliance are undeveloped, the research program would focus on testing interventions that incorporate multiple deterrence techniques. A range of techniques selected would be selected that appealed to a broad spectrum of motivations for compliance and noncompliance. Although some of the techniques incorporated in such multi-pronged interventions might have only a small deterrent effect, the aggregate effect of the intervention would be more likely to reduce noncompliance to acceptable levels than would any single deterrence technique.

Characteristic 2. Because of the NPS dual mandate it is critical that tests of proposed interventions consider both their deterrent effects and their effects on visitor experiences. Unfortunately, our limited knowledge about the experiences expected by NPS visitors currently provides a poor basis for predicting visitor reactions to deterrence techniques such as threatened punishments. Thus, investigation of visitor expectations and the ways in which deterrence techniques negatively impact visitor experiences would also be high research priorities.

Characteristic 3. Even using multiple deterrence techniques, a single multi-pronged intervention is not expected to perform adequately in all NPS units. NPS units vary greatly in their sensitivity to damage caused by noncompliance, and thus require that noncompliance be reduced to different levels. Where acceptable levels of noncompliance are low, interventions producing some negative impacts on visitor experiences may be justified, but where acceptable levels of noncompliance are relatively high, visitor experiences should be given a higher priority. By developing several multi-pronged interventions that simultaneously vary in deterrence effectiveness and negative impact on visitor experiences, this research program would allow NPS managers to maximize the balance between resource preservation and provisions for visitor enjoyment.

Characteristic 4. The effectiveness of the interventions designed in this research program will vary across applications, and some form of assessment will be necessary to determine if an intervention is performing adequately. However, NPS managers are unlikely to have the knowledge or motivation necessary to perform such assessment. This problem would be minimized by developing simplified procedures for evaluating intervention effectiveness and communicating to NPS managers the importance of using the procedures to conduct evaluation when implementing interventions.

Characteristic 5. A multi-disciplinary advisory panel would be assembled to oversee the research program thus far outlined. The panel would include members representing diverse approaches to the study of noncompliance so that the multi-pronged interventions initially tested would represent a broad spectrum of theories concerning noncompliance and would combine deterrence techniques so as to maximize their effectiveness. The panel would also include biologists and other natural scientists to provide input concerning the limits of acceptable damage for various natural resources.

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Oregon Lecture Series Addresses Global Change

by Ruth Jacobs

The Center for Analysis of Environmental Change at Oregon State University is sponsoring a series of seminars focusing on current research on global biogeochemical cycles. The Center is a cooperative partnership between Oregon State University, the USDA Forest Service, the US Environmental Research Agency, and Battelle Pacific Northwest Laboratories. Topics addressed in the spring series of 11 talks at OR/State/U were the global carbon cycle, methane emissions, chemistry of rain water, responses of vegetation to global change, and biogeochemistry of Crater Lake. This series furthers the Center's objectives of creating new collaborative opportunities for its partners and providing a focus for research and discussion on causes and consequences of environmental change.

Peter Vitousek, Stanford professor of biological sciences, opened the series with a lecture on "Beyond Global Warming: Ecology and Global Change," constituting a pep rally for the scientific community. He argued that crucial decisions are being postponed by those who would argue that the scientific uncertainty is too great for effective decision-making . Undeniably a major amount of uncertainty exists about many facets of global change, but conversely, a sufficient core of knowledge exists to define some aspects of change, predict some of the consequences, and take action in treating some problems.

There are three major classes of change that are all global, well known and well-related to human activity -- levels of atmospheric carbon dioxide are increasing, the global nitrogen cycle is changing, and monumental land-use changes are occurring. Causes of increasing levels of carbon dioxide are combustion of fossil fuels and changes in land use, both of which remove carbon from natural storage systems. Changes in climate, amounts of nutrients used by plants, composition and dynamics of biological communities, and even nutrient concentrations of some plants have been documented. These are profound changes, effective worldwide.

In terms of the nitrogen cycle, human activity has recently and rapidly doubled nitrogen fixation worldwide. Because many systems are naturally limited by nitrogen, rapid increases in nitrogen can alter the number of species in an ecosystem, change the diversity of landscapes, and alter grazing and decomposing food chains. These changes are generally viewed as negative, not positive. Increasing nitrogen levels in some communities, for example, have been shown to decrease species diversity.

The major global change in land use is the most important of the classes of change discussed by Dr. Vitousek. These land-use changes, deforestation for example, are occurring subtly, acre by acre. Remote sensing is the ideal tool for documenting the change, but the time span of the records that we can view with this tool is brief. We are left with indirect measures of the effects of the land conversions, such as the fact that between 30 and 50 percent of the net primary production of Earth is dominated, used, or foregone because of humans. That does not leave a lot for the millions of other species that exist on the planet.

These three major changes are coupled with other changes propagated by humans, such as over-harvesting of species, biological invasions of exotic species, and introduction of ozone-depleting chemicals. All together these and other changes are leading to two major events -- global climate change, which we cannot clearly demonstrate yet and cannot predict locally with much certainty, and a loss of biological diversity, which is becoming increasing evident and is truly an irreversible loss. Leading all of this change is the ever-growing human population.

Simple reversals of the changes we face are nonexistent. We can limit the amount of change we cause, but the crucial first step to setting some limits is for scientists to get active in communicating what they know rather than focussing on uncertainty. Dr. Vitousek insisted that we know a lot, and this knowledge can be used by society today to make decisions that will determine how much global change occurs. His message was that we all should actively seek out colleagues who have confidence in their knowledge and ability to effect a change, form partnerships with these people, and work actively to make a difference in the future of the world.

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Such information is critical for maximizing the balance between resource preservation and visitor experiences.

Characteristic 6. In order to maximize the effectiveness of the intervention strategy developed by the research program, testing would be done in NPS units that represent the diversity of environments and visitor populations regulated by the NPS.

Summary

Several recommendations that are useful to NPS managers can be made based on the existing noncompliance research. However, increased knowledge about the control of noncompliance is critical for the preservation of NPS resources. The creation of the National Biological Survey creates even greater opportunities to apply such knowledge to a resources on a variety of other public lands. Funding allowing, we at the U/WA CPSU hope to continue a leadership role in the investigation of visitor noncompliance and the techniques used to deter it.

Research concerning methods to control noncompliance should prove to be extremely cost-effective. Based on the survey results presented in the preceding article, research that developed means of deterring just 10% of current noncompliance in the NPS—a modest goal—could save over $5,000,000 in repairs. Distribution of such knowledge to other public land managers would entail minimal costs and dramatically increase savings. Even more important, any reduction in irreparable damage to natural and cultural resources yields benefits that are priceless.

Vande Kamp is a research consultant and Johnson is the Program Leader, Social Science, at the U/WA CPSU, Seattle. Swearingen is an Assistant Professor in the Department of Health, Physical Education and Leisure Studies at the University of South Alabama, Mobile, AL.

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Winter Mass Balance Measurements on Teton Glacier
Begin to Build Basis for Predicting Seasonal Melt and Runoff

By Kelly Elder, Sue Fullerton, and Kathy Tonnessen

Water resources in the western United States are gaining attention as both our perception and reality point toward future shortages. Persons and organizations interested in agricultural, hydropower, municipal, and recreational water use now are showing keen interest in every drop flowing down western rivers. In many cases the rivers are overallocated and demand exceeds the supply.

The greater Yellowstone region encompasses headwater basins critical to some of the most important water sources in our nation, including the Columbia, Colorado, and Missouri River basins. Grand Teton National Park (NP) contains one reservoir dedicated to agricultural water storage and the supply to this reservoir is primarily from snowmelt. The reservoir, which predates the park's establishment, is the first in a long list of containments on the Snake River.

In order to manage water resources efficiently and realistically, we need to improve our methods of prediction for supply and runoff. Uncertainty about climate change makes our predictive capabilities subject to considerable error. In mid-latitude alpine regions much of the annual precipitation is stored as snow during the winter. Slight changes in climate may make large differences in the amount of precipitation and storage in the form of snow. Glaciers offer a long-term record of climate by storing information lost in the seasonal snowpack which melts annually on nonglacier surfaces.

Mass balance, the gains and losses of ice mass over time from a glacier, is the primary parameter with which we can couple glaciers to climate changes (Meir, 1992). There is evidence that the Earth's ice sheets are not decreasing in volume (Bentley and Giovinetto, 1992), and that the observed rise in global sea level may be attributed partly to negative mass balance in mountain glacial systems (Meier, 1984; Jacobs and Hellmer, 1992). Small alpine glaciers such as Teton Glacier in Grand Teton NP are more sensitive to climate change than larger glaciers and ice sheets, providing relatively accessible information about subtle changes in modern climate. However, detailed mass balance measurements rarely are made and measurement data spanning more than a decade are scarcer still.

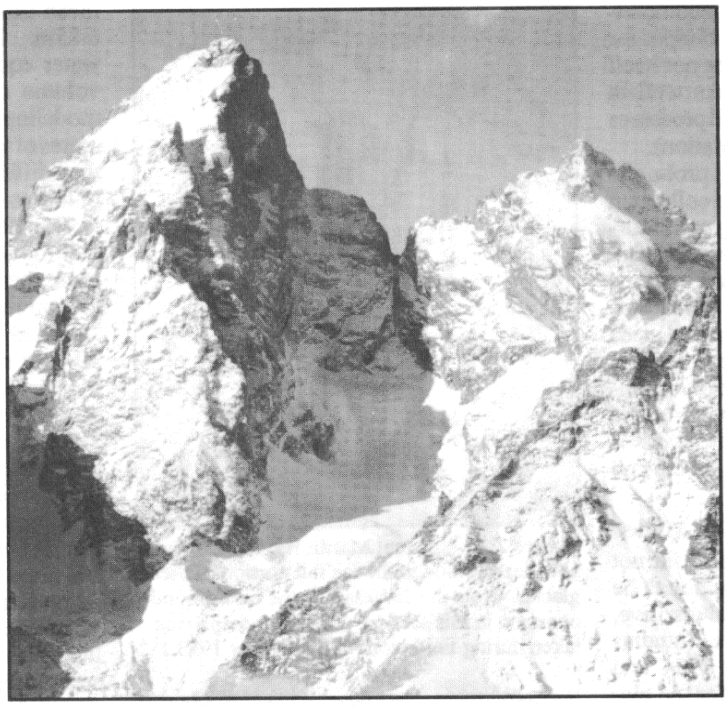

Figure 1. Teton Glacier surrounded by the Grand Teton on the left, Mount Owen in the center, and Mount Teewinot to the right. Teton Glacier occupies the shaded cirque in the center of the photograph below Gunsight Notch. The glacier's large terminal moraine extends from the East Ridge of the Grand Teton. This photo was taken from the east after the first significant snowfall in October 1993.

The National Park Service has acknowledged the importance of glacier studies in Global Change research and, in particular, detection of climate change through mass balance changes (National Park Service, no date). Glaciers of Grand Teton NP offer unique opportunities for climate change studies relating to the entire Greater Yellowstone Ecosystem.

When winter snow accumulation is measured at, or close to, the date of its peak, an estimate of winter mass balance can be made. A similar survey at the date of minimum snow cover, at the end of the ablation season, gives a value of summer mass balance. A multi-year record of summer and winter mass balance provides clues to changes in overall glacier mass balance resulting from climate perturbations. Seasonal snowpack mass is measured in terms of snow water equivalence (SWE). SWE is simply the amount of water that would be produced if the snow were melted simultaneously at a point, or if the depth of snow were multiplied by the snow density where density is expressed as the percent of the density of water.

Results reported are the first of a series of surveys designed to measure winter and summer mass balance of Teton Glacier. These measurements will be a valuable baseline for future climate change studies carried out in the region. This research project also demonstrates the value in using GIS techniques to extrapolate from point measurements to spatial estimates of snow water equivalence.

Study Site

Teton Glacier is located in the Teton Range of Wyoming. The glacier lies within Grand Teton NP at about 43 44'30"N and 110 47'31"W (4,842,985 N and 516,755 E UTM) and ranges between 3,095m and 3,500m above sea level. Teton Glacier occupies a deep cirque surrounded by steep walls of the Grand Teton (4,196m) to the south and Mount Owen (3,937m) to the north (Fig. 1).

Methods

To calculate SWE, systematic field measurements of snow depth and density were gathered from May 17 through 20, 1993, the time of peak snow accumulation for the year.

To measure density, snow pits were dug at two sites, with dual snow density profiles. Snow temperature and stratigraphy also were observed and recorded. From these values an estimate of density as a function of snow depth was derived.

Aluminum probes were used to measure snow depths at intervals of approximately 10 meters along 5 major transects (Figs. 2 through 4). One vertical transect extended the length of the glacier from the terminal moraine to the head of the accumulation area, while four horizontal transects were positioned across the first. Five additional point measurements were made at locations where probing was too difficult for an entire transect to be completed. In all, 201 depth measurements were made. From these depth values, combined with density values from the snow pits, SWE (depth x density) at points along the transects were calculated.

Further analysis required addressing a classic geographic question: How do we distribute point values over a surface? Many attempts have been made to do this in glacio-

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logical contexts (e.g. Young, 1974 and 1975; Paterson, 1981; Elder et al., 1992; Elder and Yang, 1992). Four interpolation techniques for modeling such a distribution of SWE over the glacial surface were selected for comparison. Each required elevation as an input for calculation. While elevation does not itself affect snow distribution, it works well in many cases as an index for physical processes that do (i.e. temperature, precipitation).

Estimates of elevation for each probe site might be obtained by relating field collection locations to an established topographic surface, such as a USGS 1:24,000 contour map. However, geographic information systems (GIS) can create and use computerized equivalents of such maps. Comprised of cell grids covering the area of interest, these digital elevation models (DEM) have elevation values assigned to each cell throughout the coverage. Thus, any mapped site is automatically assigned the elevation for the cell upon which it falls.

Constructing a Digital Elevation Model

The standard USGS 30m DEM did not offer sufficient resolution or accuracy to be used in the data analysis. As an alternative, maps were located from USGS field studies (Reed, 1964), which presented 1954 and 1963 margins and contour lines for the glacier. When processed into a digital elevation model, these maps provided the necessary DEM. From the digitized version of this map, a DEM was generated at 5m resolution using GRASS (GIS) software. The choice of cell size ensured that field data, collected at 10 m intervals, would occupy separate cells when referenced back to the map.

Registering field locations to such a DEM was the next step to make the map functional. Probe sites originally were marked off in sequence along each transect from an established point in the field. Distances between successive sites were measured while traveling up the glacier surface from each previous point. Sequential points measured along an ascending slope will, necessarily, lie closer together when placed upon a flat map. Slope and azimuth determined at each field location were used to calculate the corresponding horizontal distance traveled. The resultant UTM coordinate pair represented the proper location on the Reed map for each field site. All field points now took their correct locations within the digitized map margins and the elevations value for each on the DEM could be applied to its respective field position. The 5m DEM and locations of the field measurements are shown in Figure 5.

SWE at all points now could be estimated as a function of elevation. Models programmed across the entire surface resulted in estimates of SWE volume for the entire snowpack. In addition, the average SWE

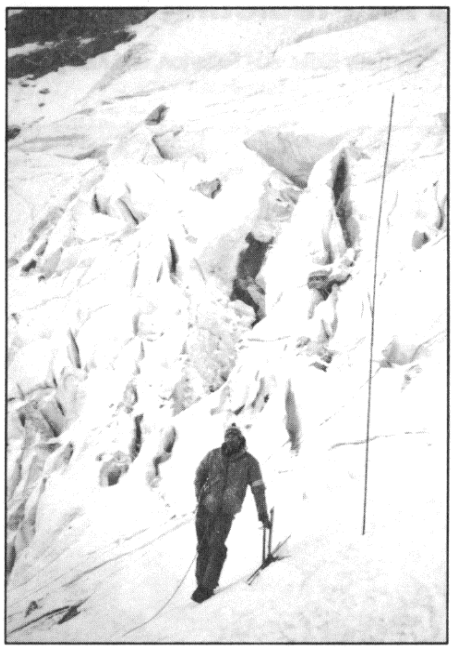

Figure 2. Field hand Martin Hagen with portable depth probe in the ice fall portion of the glacier. Note the crevasses in the background common in this section. The photograph was taken during field work in September 1993.

was calculated as the total volume divided by the area of the glacier. A second feature of DEMs is the capability of deriving distributed slope and aspect cell values from their corresponding elevations. Using these values to locate areas of steep slope, an index of avalanche probability was defined upon the surface. These areas accounted for additional snow depth due to local redistribution of snow by avalanching.

Modeling Snow Water Equivalence

Four methods of interpolating the depth and density measurements were used. These included: (1) dividing the glacier into evenly spaced elevation zones and assigning the mean of all the measurements within each zone to that zone; (2) linear regression of measurements against elevation; (3) binary regression tree using elevation as the independent variable, and (4) binary regression tree using elevation and an index of avalanche activity as independent variables.

The first two methods are conventional techniques often applied in glaciological and hydrological studies; the binary tree classifier was experimental in the glaciological context and was used here in an attempt to better refine the model and to introduce one element of snow redistribution.

Results

The binary regression tree method using elevation and the avalanche index as independent variables provided the most accurate distribution of snow based on statistical analyses of the field data. Figure 6 shows the results of the binary regression tree method using elevation and the avalanche index. Based on the models, the best estimate of mean snow depth on the glacier was about 6.85m. The best estimate of mean snow water equivalence was 3.22m with a total volume of about 970,000m^3. The other modeling methods produced similar estimates of total snow storage on the glacier, but they differed significantly in the distribution of the snow over the glacier surface.

The 1993 water year was just below normal for snow accumulation based on long-term measurement stations in the region (Wyoming Basin Outlook Reports, 1993). "Normal" in this context is defined as the 30-year mean, taken from 1961 to 1990. Martner (1986, p. 79) shows an isohyetal map of annual precipitation that places the Teton Range within the 1.5m (60") isohyet. This estimate is based on a complex relationship between topographical information and long-term precipitation and snowpack measurements, both of which are sparse in mountain areas. Martner (1986, p. 84) shows the Teton Range receiving less than 20 percent of annual accumulation during the months of June through August. Subtracting out 20 percent for summer precipitation, the winter accumulation based on the isohyetal map would be about 1.20m water equivalent. Although the values in Martner's map must be applied with caution, we can compare

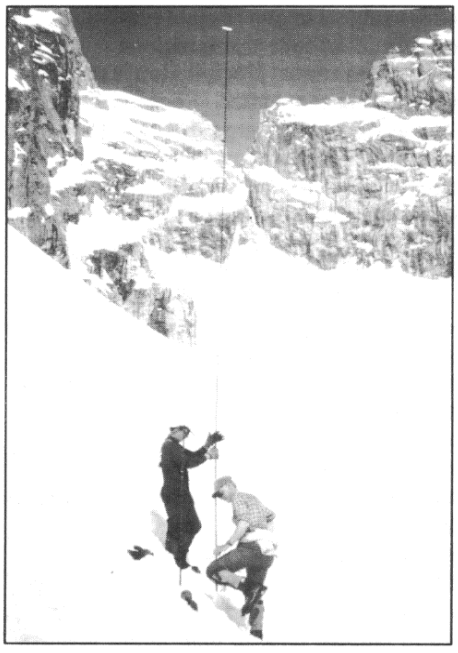

Figure 3. Rod Newcomb and Robbie Fuller take a depth measurement in an avalanche debris cone on the southeast margin of the glacier. Gunsight Notch is in the background between the flanks of the Grand Teton on the left and Mount Owen on the right.

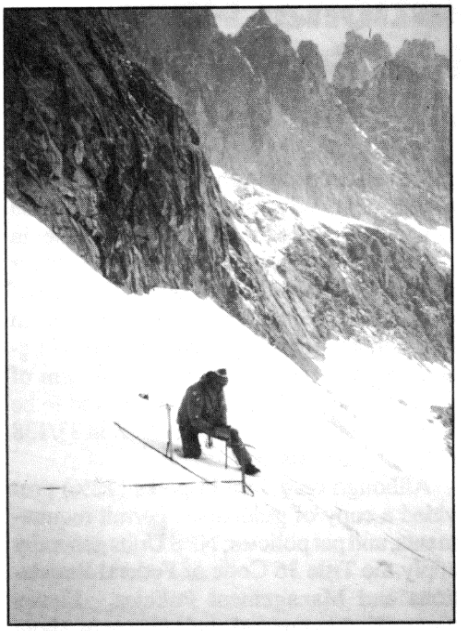

Figure 4. Martin Hagen in the accumulation zone above the ice fall. Snow depths in the area averaged greater than 10m. Mount Teewinot is in the background.

them to our modeled results for accumulation on Teton Glacier. The expected aerial average from Martner of 1.20m compared to our modeled accumulation of 3.22m shows 2.7 times the expected value.

It is believed that the high value of accumulation is attributable to high rates of orographic precipitation, leeward deposition of suspended snow load, and redistribution of local accumulation by avalanching on to the glacier from surrounding slopes. Teton Glacier occupies a deep cirque flanked by the two highest peaks in the range. These peaks, and the arete between them, lie to the west or windward side of the glacier, effectively creating the largest eddy or potential lee-side deposition area in the range. This fact, combined with avalanching and the southerly blockage of solar irradiance, gives the cirque a high accumulation potential. Note that most of the other east-facing cirques in the Tetons do not contain glaciers.

The accumulation gradient observed on the glacier is remarkable. The gradient was calculated for the cirque area covered by field measurements using linear regression of SWE based on elevation. Using only the field data, a value of 0.84m SWE per 100 m elevation gain was found. The large gradient is applicable to this portion of the cirque only; it predicts no snow cover below an elevation of about 2,900 m elevation which is contradictory to the existence of substantial snow cover in the valley floor at 2,080m. Other localized cirques in the range with similar morphometry may have such accumulation gradients.

Summary

This study has produced two relevant conclusions. The first is that seasonal snow inputs to Teton Glacier may be a great deal larger than expected for the region. The second is that although a neophyte statistical modeling technique, the binary regression methods may prove to be a useful tool in mass balance estimation on glaciers with variable accumulation patterns (Chambers, 1992), complex topography (Kuhn et al., 1985) and where a glacier exists over a variety of climate conditions (e.g. accumulation area in the alpine with the toe at sea level).

The conclusions and analytical methods applied in this study are valid for the 1993 water year only. Accumulation in the region was close to normal, and it is believed that the distribution of snow on the glacier was typical of normal years. More years of field work and analysis are needed on Teton Glacier before any of the results can be taken as normal. Additional years of field data collection and analysis will allow us to establish "average" accumulation and melt patterns, so that we can then attempt to predict changes in seasonal melt and runoff that may accompany changes in regional precipitation and temperature.

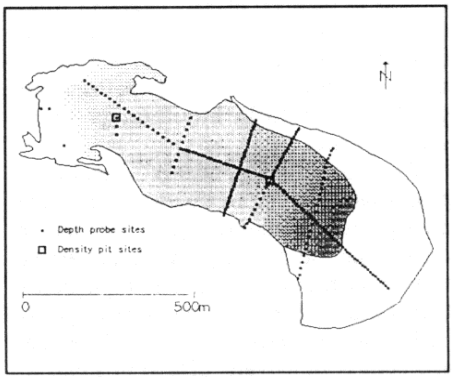

Figure 5. Digital map of 5m DEM constructed from contour map (see Fig. 3). Lighter shades represent higher elevations; darker shades, lower elevations. The line dissecting the area from top to bottom is the approximate terminus of the glacier. The line to the east of the present glacier area represents the terminal extent and moraine of the glacier at its maximum during the "Little Ice Age."

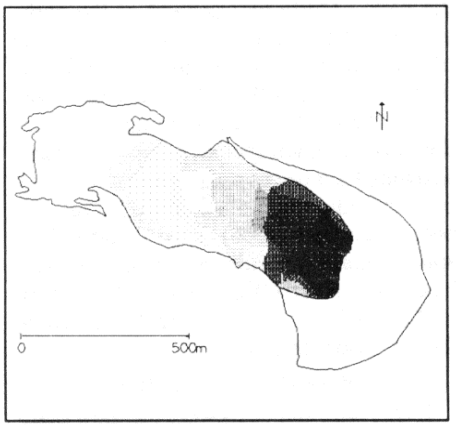

Figure 6. Digital map of snow water equivalence on the glacier surface. Snow was mapped using a binary regression tree with elevation and an avalanche index as independent variables. Lighter shades represent areas of greater snow accumulations; darker shades, shallower snowpack areas.

Elder is a graduate student at U/CA Santa Barbara; Fullerton is a GIS Specialist with the Resource Management Division at Grand Teton NP; Tonnessen in Director of the Biological Effects Program of the National Biological Survey Air Quality Division in Denver. *This research was funded by the Grand Teton Natural History Assn.; support for the first author was provided by NASA's EOS program.* *Comments and questions should be addressed to Kelly Elder, Box 52, Wilson, WY 83014, or Sue Fullerton, Resource Management, Grand Teton NP, Moose, WY 83012.*

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Animal Disease Issues In The National Park System Clarified By Nationwide Survey

By Alonso Aguirre, Edward Starkey, and Donald Hansen

Animal diseases are potentially significant management concerns in a number of units of the National Park System. Some of these diseases are a threat to human health; others are of primary concern because of potential impacts to domestic livestock on adjacent park lands; and still others may threaten native wildlife populations.

Therefore, to identify key animal disease issues, we conducted a nationwide mail survey of national parks, federal and state agencies, and universities. In addition to wildlife diseases in national parks, participants were questioned about the implementation of wildlife and domestic animal health programs including treatment, control, and management of wildlife diseases (e.g. vaccination, medication, herd management, quarantine, and habitat management). Information was also compiled on the use of pack animals and pets, livestock grazing in park ecosystems, and policies and regulations on domestic animal management within the park. In all, 503 questionnaires were mailed to 179 units of the NPS and 324 universities, state, and federal agencies. Overall we obtained a response rate of 70 percent.

Sixty-eight percent (94/138) of the national parks surveyed indicated that at least one animal disease related issue had been of concern in the last 10 years. In general, other agencies' responses indicated that 29 percent (57/196) have reported wildlife disease issues in or adjacent to NPS units in their state. Fish & game agencies were most commonly involved in wildlife disease research and management (54%). State departments of health (42%) reported zoonotic diseases involving wild carnivores and rodents. Sixteen percent (9/55) of Animal & Plant Health Inspection Service (APHIS) respondents reported bovine brucellosis as the greatest concern regarding animal disease issues in the National Park System.

Domestic Livestock Diseases

Serologic studies (13%) demonstrating the presence and prevalence of domestic livestock diseases including bluetongue, bovine respiratory syncytial virus, bovine virus diarrhea, infectious bovine rhinotracheitis, parainfluenza-3, and vesicular stomatitis were reported in wapiti, deer, bighorn sheep, moose, and caribou. Lungworm-pneumonia complex in bighorn sheep and epizootic hemorrhagic disease in white-tailed deer were the most important disease issues affecting wild ungulates in national parks. Several cases of hemorrhagic disease in deer and bighorn sheep were reported based on clinical signs and lesions; however, no laboratory confirmation was made to differentiate these diseases. Parelaphostrongylosis in elk and deer, psoroptic scabies in bighorn sheep, leptospirosis in deer, and pseudorabies in feral pigs apparently represent an increasing threat to native ungulate populations.

Rabies (22%), sylvatic plague (14%), canine distemper (11%), Lyme disease (9%), and endoparasites (i.e. heartworm and raccoon worm) (9%), were the most common diseases reported affecting carnivores and rodents in national parks. Diseases which may be increasing in zoonotic importance include trichinosis in wild carnivores; tularemia in rabbits and beavers, and leptospirosis, giardiasis, and Rocky Mountain spotted fever in rodents.

We requested information on animal health programs including treatment, control, and management of diseases (e.g. vaccination, medication, herd management, quarantine, and habitat management). The implementation of wildlife health programs was reported by 19/138 (14%) national parks. Treatment and control of sylvatic plague in small rodents, by dusting burrows and closing visitor areas, were the most common practices implemented by park personnel. Treatments were also reported for lungworm-pneumonia complex and psoroptic scabies in bighorn sheep.

We compiled information on the use of pack animals and pets, livestock grazing in park ecosystems, and policies and regulations on domestic animal management within the park. Thirty-two percent of the parks surveyed did not allow or report the presence of pack animals inside their boundaries. Horses (38%), followed by mules/burros (10%), llamas (5%), and sled dogs (3%) were the most common species reported in parks allowing their use as pack animals. Grazing occurred adjacent (36%), inside (11%), and both in and near (13%) national parks. The species grazing inside or adjacent to NPS lands were cattle (60%), horses (21%), sheep (14%), and other species (5%) including llamas, bison, and goats.

Park Policies For Pets

Dogs, cats, and birds were the most common pet species allowed to be kept by park personnel and visitors inside national parks. Seventy-one percent of parks responding allowed pets on a leash with different degrees of restriction. For example, pets could enter the park if confined in a vehicle, kennel, or restricted to concession areas. Other national parks allowed pets on a five to 6-foot leash within 100 feet of the road or shoreline; in developed areas, pavement, campgrounds or overlooks; or within one-fourth of a mile of developed roads, on trails but not in backcountry, and only during the day. Unrestrained pets were allowed in 3 percent of parks (4/138). No pets were allowed to be kept by visitors or park personnel in 33/138 (24%) NPS units.

Although only 16/138 parks (12%) provided a copy of guidelines, permit requirements, and pet policies; NPS Units generally apply the Title 36 Code of Federal Regulations and Management Policies. Eleven parks (8%) expressed their concerns about free-ranging feral dogs and cats, sled dogs, and unleashed pets. Contact between feral animals, pack animals, or pets and wildlife was reported as frequent, representing an increasing threat or health risk to native species. Carnivore species including wolves, coyotes, foxes, puma, lynx, and bobcat are vulnerable to infectious diseases such as canine distemper, parvovirus enteritis, and feline panleukopenia.

Human health issues were reported by 61 percent of parks surveyed (84/138). Several confirmed cases of Lyme disease in humans were reported in the following parks: Point Reyes NS, California from 1987-1990 (3/9 cases); St. Croix and Lower St. Croix NSR, Minnesota (high prevalence among human and animal populations; 50 percent of park staff has been diagnosed and treated since 1987); Cuyahoga Valley NRA, Ohio (three cases); Crater Lake NP (one case); Delaware Water Gap NRA (one case) and Valley Forge NHP, Pennsylvania (two cases); Big South Fork NRRA and Obed WSR, Tennessee (confirmed in several park employees and visitors); Colonial NHP (one case) and George Washington Memorial Pkwy, Virginia (one case). Giardiasis was reported only in Rocky Mountain National Park, Colorado, and North Cascades NP, Washington, but the disease is undoubtedly present in other parks. Human leptospirosis, possibly acquired from wild pigs, dogs, or cats, was reported in Hawaii Volcanoes NP (three cases). LaCrosse encephalitis was reported in St. Croix and Lower St. Croix NSR, Minnesota and Cuyahoga NRA, Ohio (one case in 1981). Relapsing fever was reported in Grand Canyon NP, Arizona (six cases since 1990). Rocky mountain spotted fever was confirmed in a human fatal case in Cape Cod NS, Massachusetts in 1990.

Avoidance Techniques

In nine percent of national parks surveyed, visitor use and access was restricted to avoid human contact with wildlife and reduce the risk of disease transmission. Management techniques included bearproof garbage cans, closure of visitor use areas (caves, trails, picnic areas, and campgrounds), and restriction of use to developed trails. Interpretive or educational programs designed to inform visitors about risks and/or prevention of wildlife-borne diseases were reported by 43 percent of parks (59/138). These interpretive programs were focused primarily on the prevention of sylvatic plague and rabies. Hunters received information and were asked to report contagious ecthyma in mountain goats and Dall sheep in national parks in Alaska (contagious ecthyma can readily be spread to humans by direct contact). Interpretive and educational programs commonly used included direct contact on an individual basis, warning signs in visitor centers and use areas, slide shows and lectures, posters, pamphlets, brochures, leaflets, and posted information in bulletin boards.

Thirty eight percent (53/138) of NPS respondents considered that the occurrence of diseases and parasites in wildlife in park ecosystems is part of a naturally functioning ecosystem. The general consensus in the survey was that native diseases should be protected even if they are detrimental to wildlife populations. Parasites and diseases should be allowed to perform their natural functions in the ecosystem within the full range of what might be considered natural. Native diseases should only be managed to protect adjacent areas or to preserve ecosystems that have been altered or threatened in part by human influences, for protection of endangered species and species of special concern, for public health reasons, and for "display" populations (those very important for visitor enjoyment), to the extent that treatment does not detract from the appearance of naturalness (NPS 1988).

A number of respondents listed several issues to be considered in making decisions concerning control of diseases in national parks. These include status of the infected animal population, classification of disease as exotic or native, pathogenicity and infectiousness of the etiologic agent, and capacity to infect other hosts (domestic animals and humans). Most parks surveyed concluded that diseases introduced by humans and domestic livestock or pet animals should be eradicated from national parks.

Immediate Disease Issues

National parks, state, and federal agencies were asked to identify the most immediate disease issues that should be addressed in the National Park System, if funding became available. Highest ranked priorities of NPS respondents were Lyme disease, sylvatic plague, BHS disease, rabies and giardia while brucellosis, lyme disease, BHS disease, rabies and tuberculosis reflected the relative priorities of other agencies. Differences in priorities between NPS and other agencies undoubtedly result from differing objectives and legal mandates of agencies reponding to the survey. For example, NPS respondents were most concerned with diseases related to public health, such as sylvatic plague and Lyme disease. On the other hand, APHIS considered brucellosis the most important issue facing national parks. Although brucellosis can infect humans (undulant fever), pasteurization of milk has reduced its public health threat. However, in some areas, it remains a serious disease in domestic livestock and APHIS is responsible for issues affecting the health of domestic animals.

Because pack animals and domestic livestock are common in and near national parks, disease monitoring programs should be established which could detect transmission of diseases among native wildlife and livestock. Such a program would be of value to managers of parks, as well as those managing adjacent grazing lands.

Pet diseases represent a potentially serious threat to park wildlife populations. Although most parks allow pets only on a leash or in restricted areas, several respondents were concerned that leash requirements often are overlooked by visitors. Pets from different geographic regions represent a health risk to national park wildlife populations, and enforcement of regulations is critical to reduce the likelihood of exotic diseases and parasites entering national parks. With increasing numbers of visitors and pets, and with increased mobility, the potential for introduction of new diseases also is increasing.

This work was supported by Special Initiative funding from the NPS Wildlife and Vegetation Division, Washington, D.C. We wish to thank Drs. John Dennis, and Sharon Taylor for advice, encouragment and review of the final report (Aguirre, A.A., D.E. Hansen and E.E. Starkey. 1993. Special Initiative Project: Animal Disease Issues in the National Park System. USDI, National Park Service, Pacific Northwest Region, Cooperative Park Studies Unit Technical Report NPS/PNROSU/NRTR-93/16. 126 pp.)

Aguirre was, and Hansen is currently with the College of Veterinary Medicine; Starkey is with the National Biological Survey, Coop. Park Studies Unit, OR State Univ., Corvallis. Aguirre is presently with Wildlife Laboratories Inc, P.O. Box 1522, Fort Collins, CO 80522.

Assateague Island Mares 'Shot' With Contraceptives

In January 1994, Assateague Island NS staff met with Dr. Brian Underwood, NBS, to discuss the application of a draft population dynamics computer model for the feral horses. Population projections are based on known historic genealogy, fecundity, mortality, and density-dependent birth and survival correlations. Preliminary model simulations which factored in modest natural mortality indicated a continued rise in the population over the next decade. An environmental assessment was prepared to assess feral horse management alternatives for 1994.

The approved alternative was to treat all mares with a single dose of immuno-contraception for one year in order to suppress population growth in 1995. Thanks to a combination of good luck and good shooting, the goal of 76 adult mares was achieved in 15 actual field days of darting. For 28 of these mares which have been a part of the ongoing immuno-contraception research, this shot should provide near 100 percent effectiveness. Past research indicates that the initial dose could provide contraceptive effectiveness of up to 70 percent for the remaining mares. Park staff expects 27 births in 1994 and 10 births in 1995. According to the population model, the 1994 treatment appears to at least stabilize the present population. The treatment also conditions all reproductive age mares for the future use of immuno-contraceptives.

The Delaware Water Gap NRA, Upper Delaware Scenic and Recreational River, and Delaware River Basin Commission recently sponsored an Upper Delaware Water Quality and Biological Monitoring Conference that included participation by 51 individuals from 23 agencies and citizen volunteer groups. A similar workshop was held in 1987. Seventeen agencies and organizations are actively involved in monitoring water quality in the region; a representative from each described their monitoring activities. Discussions focussed on macroinvertebrate monitoring methods and experiences. As a first step towards interagency standardization of methods, technical representatives of the agencies agreed to meet later in a field session.

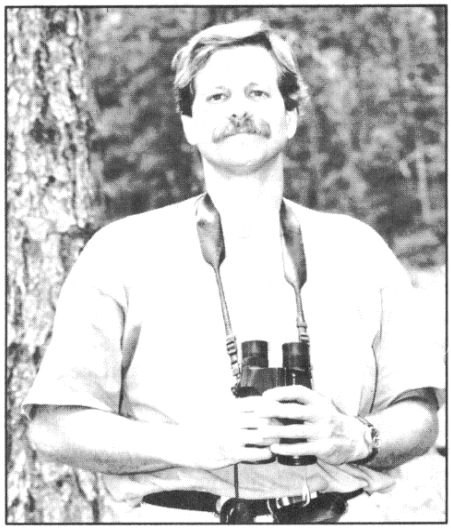
Jeff Selleck Succeeds Jean Matthews as *Park Science* Editor

The Natural Resources Publication Office of the NPS Associate Director for Natural Resources has selected Big Bend NP Interpretive Supervisory Park Ranger Jeff Selleck to succeed Jean Matthews as editor of *Park Science*. Matthews, the publication's founder and editor throughout its 14 year history, plans to retire later this year in Washington state and will turn over editorial responsibility to Selleck this summer when the fall issue goes into production in Denver. The specter of Matthews' departure, a matter of concern to all associated with the publication, led to Selleck's appointment to the post last December.

Selleck is shifting careers in coming to *Park Science*. As an interpreter and supervisor at Yellowstone, Everglades, and Big Bend NPs during the past 10 years, Selleck specialized in guiding walks and giving evening programs that primarily interpreted birds, volcanic geology, and ecosystem threats. In 1989, he won the Freeman Tilden Award for the Southwest Region in recognition of his abilities as an outstanding interpreter. In recent years, his skills and experience expanded to include writing exhibits and site bulletins, and editing and laying out the award-winning *Big Bend Paisano* newspaper.

He brings to *Park Science* communication skills, experience in layout and design, a link with the field, and a commitment to the mission of the National Park Service. "Every time I visit a national park, I become more interested and excited about the diversity of wonderful resources that we protect and present to the public," Selleck commented. "I also become concerned about the many complex resource management issues that face us. I love our parks and I want my association with this bulletin to help further science-based resource management programs, decisions, and solutions."

Park Science currently is undergoing a nine-month transition from Matthews to Selleck. During this time, the publication will be moved from the Pacific Northwest Region to Denver, where Selleck has an office in the Denver Service Center building. The editor-in-training presently is working out details of the changeover; collecting articles and developing contacts at conferences and meetings; preparing for desktop publishing production of the quarterly; generating ideas for future articles; visiting with resource managers and scientists in the field; tracking progress with natural resource programs, such as R-MAP and NRPP; and redesigning the distribution list database. He will begin editing articles and doing the layout for the fall issue, in which he will new procedures for submitting material to *Park Science*.



Selleck inherits a publication that has grown both in distribution and importance. When it began in 1980, *Pacific Park Science* was circulated only within the Pacific Northwest Region, but it soon included the entire National Park System. Acting on feedback from the field, Matthews refined the publication's niche in the overall NPS mission effort into a way of communicating findings and science-based resource management, with emphasis on their implications for park managers. The approach has appealed to an ever broader audience in the natural resource field—inside and outside of government at all levels, and especially in the academic community, where it is widely used as course material.

Selleck plans to build on the established foundation of publishing good field science and resource management. However, sweeping changes with the science program during the past year will require careful attention from the new editor. "*Park Science* will certainly become an important link between the evolving National Biological Survey and the NPS as we begin to understand how to make use of the new agency's services," Selleck said recently. "While I hope to publish park-relevant research from the NBS, more importantly I hope to encourage and develop additional authors within our own ranks as we continue to professionalize the resource management field."

Also of interest will be exploring the idea of ecosystem management for the National Park System and looking beyond park boundaries for solutions to resource management problems.

Donna O'Leary
NPS Publications Coordinator

Cut out this card and place it in your Rolodex!

Park Science

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Long-term Monitoring on a Shoestring at Apostle Islands

By Julie Van Stappen

At Apostle Islands National Lakeshore (APIS), an effective, low-cost, long-term monitoring program has been developed over the past few years. This article describes how resource managers in small to medium sized parks can undertake long-term monitoring despite very limited resources.

APIS is a 42,000 acre park with 21 islands and a small mainland unit lying along the Lake Superior coast in Wisconsin. The islands range in size from 3 to 10,000 acres; the mainland unit is approximately 12 miles long and less than 1 mile wide. The lakeshore is near the northwestern edge of the hemlock hardwood forest and the southern fringe of the boreal forest. The most dominant forest type is northern hardwood, most of which is >50 year old second growth. The lakeshore also has aspen/birch, oak, upland conifer, and pine forest. Special habitats include a wide variety of dunal features, bogs, sandstone cliffs, clay banks, old-growth forest, colonial bird nesting sites, migratory bird concentration areas, and bald eagle nesting sites.

Karin Kozie and Mark Mackey collect a bald eagle blood sample for toxic analysis (*Photo by J. Van Stappen*)

When I transferred to the park in 1988, a park goal was to establish a long-term monitoring program. Some such projects already were occurring in the park, but they were spearheaded by University researchers and personnel from other agencies without NPS funding so there was no guarantee they would continue. At the time, only part-time assistance from a seasonal biological technician was available. I started by looking at existing projects for their appropriateness and identified important gaps.

Following the lead of Channel Islands National Seashore, we wrote monitoring guidelines for each existing or proposed project. The guidelines included an introduction describing what needed to be monitored and why, and a history of past research and monitoring; objectives; methods; equipment needed; areas to be monitored and frequency of monitoring; number of personnel required/hours or days/FTE; and references. Some of the first guidelines written included bald eagles, colonial birds, ruffed grouse, woodcock, merlins, piping plovers, sandscapes (dunal features), bluff erosion, and campsites.

The primary objective of most monitoring projects is to determine the status and trends of a resource and/or to monitor visitor impact. Projects that monitor visitor impact are specifically designed to gather data for making management decisions; however, both types of monitoring provide important information for management decision-making.

The 1989 field season was the first year for the fledgling monitoring program. Many new and on-going projects were formalized. It was an important year to test methods and to determine the time needed per project, the appropriate frequency of monitoring, and the general feasibility of each project. Following the 1989 field season, all monitoring guidelines were reviewed and revised to reflect lessons learned.

Prior to the 1990 field season, the biological technician position was extended to six months and its description re-written to include, as a primary job element, assistance with monitoring. Projects added in 1990 included breeding birds, migratory birds, frogs and toads, and purple loosestrife. In 1991, mollusc monitoring was added and repeat monitoring had begun. By the end of the 1992 field season, many of the projects had been repeated and data from previous years could be compared, beaver monitoring was started, and a fairly large loosestrife control program was begun. Need for loosestrife control was based on monitoring results. Rare plant and forest vegetation monitoring are planned.

Guidelines are an important tool; they force you to evaluate each monitoring project. If you can't justify a given project, it should be reconsidered. Guidelines provide important institutional memory. They should be written so that someone unfamiliar with the project can repeat it and obtain data comparable to past results. They also should contain information on time and personnel needs, facilitating scheduling. Having all the information in one place that is needed to conduct a monitoring project provides critically needed organization during the hectic field season.

Quality control and assurance should be part of each monitoring project, and data management is an important consideration. Ideally, data should be entered into a park database immediately following completion of each monitoring project, but no later than the end of the field season. Monitoring reports should be written annually. Some of our reports are simply memos stating the results of general surveys, such as ruffed grouse or woodcock. Other reports require considerable data analysis and are many pages longer. Finally, monitoring guidelines should be considered dynamic documents and be reviewed and revised on a regular basis.

Long-term monitoring programs need to be institutionalized. Staff come and go, so the success of such programs depends on their being set up in such a way as to continue over the long run. Steps we have taken to institutionalize APIS's program include monitoring guidelines, incorporation of monitoring projects into the park's Resource Management Plan, and incorporation of monitoring duties into position descriptions and performance elements.

APIS's monitoring program covers a wide variety of projects that are skill rather than funding intensive. Without additional funding, the program focus has been on high priority projects that can be done by well-trained biologists, and that do not require outside expertise or expensive equipment. Although there are high priority inventory and monitoring projects that do require additional funding and personnel, much has been done using our own limited resources and assistance from highly qualified volunteers.

If you are a Resource Manager in a small or medium sized park, don't wait for additional funding or personnel. Start with what you have, check around with others as to how to put it to best use, and then build on it as you can.

Van Stappen is Resource Management Specialist at Apostle Islands National Lakeshore.

Public Education Pays Off At Great Smokies In Smooth Sailing For Red Wolf Release

By Napier Shelton, Robert Miller, Karen Ballentine and V.Gary Henry

Public support can spell the difference between success and failure of a resource management project, especially one that could be controversial. It is instructive, therefore, to look at public education programs that engendered support. One such success story has to do with the information effort preceding and accompanying the release of red wolves in Great Smoky Mountains National Park (GRSM).

The goal of the U.S. Fish and Wildlife Service (USFWS) recovery plan for the endangered red wolf is 220 individuals established in the wild in three areas of the Southeast (and 330 in captivity). An earlier plan to restore red wolves at the Tennessee Valley Authority's (TVA) Land Between the Lakes in Kentucky and Tennessee was suspended because of public opposition, primarily from agricultural, hunting, and animal rights groups. Learning of this experience, the USFWS and conservation groups conducted an intensive public education program around the Alligator River National Wildlife Refuge in coastal north Carolina, and subsequently carried out successful red wolf restoration there.

A similar approach was taken at GRSM. For nearly two years before the first red wolf release, in November 1991, the National Park Service (NPS) and the USFWS jointly carried out a broad public education effort to explain the reasons for and goals of the project, aimed at allaying any fears and gaining support.

The primary audience was park neighbors, most of whom live on small acreages, in small towns near the park, or in the cities of Knoxville, TN and Asheville, NC. Because of the rough foothill topography, most farms are small and most farm owners have jobs elsewhere. Tourism is a major and increasing component of the economy, and there is a growing population of retirees. Hunting remains an important part of life for many people here.

Extensive planning went into the public information program. Representatives from USFWS, park management, resource management, public affairs, and interpretation brainstormed to identify interest groups, sensitive points, appropriate media for conveying messages, and timing of efforts. Lists of groups to be contacted were developed, but the persons who were to contact specific groups were decided upon only as the effort developed.

Kim Delozier, Great Smoky Mountains National Park wildlife biologist holding up a 6 week old pup of the first litter to be born in Great Smoky Mountains National Park in 100 years. *May 1991 photo.*

The Communication Effort

The public information program began with briefings of the Tennessee and North Carolina congressional representatives and governors' offices by the USFWS Red Wolf Coordinator and regional director. The superintendent, UWFWS coordinator, and NPS resource management and science personnel, in various combinations, also talked to NPS and USFWS officials in Washington, DC and the region, local officials, farm bureau heads, and heads of state and federal land management agencies. Contacts with these key officials were followed by presentations to civic, school, conservation, and other groups by NPS public affairs and interpretation personnel, with input and assistance from the superintendent, USFWS project personnel, and others.

The park public affairs officer and resource management/environmental education interpreter, with assistance in some cases from the Southern Appalachian Man and the Biosphere Cooperative (SAMAB) and NPS staff developed various tools for communicating information about the red wolf project. Among these were a slide program, brochures, poster, periodic updates, video (in cooperation with station WBIR-TV in Knoxville, TN), traveling exhibit, a wayside exhibit, and teacher's guide (including lesson plans) to the video and poster.

The video/poster/teacher's guide package was sent to 800 schools, libraries, nature centers, and other requesters. In addition, 7,000 posters were distributed. The 30-minute video, "Front Runner," and an earlier short video piece presented the background, plans, and early activities of the red wolf project, including the temporary release of a red wolf family, reasons for the project, and viewpoints of various people. These latter included local farmers who feared the presence of red wolves would result in livestock depredation. An update of the video incorporating developments after permanent release of a second red wolf family later was produced. Because of the demand for the video/poster/teacher guide package, an additional 1,000 videos and 3,000 posters have been produced.

Program Progress Updates

Media representatives have been kept informed through press releases, press conferences, a red wolf newsletter, and media briefing packages. Park visitors learn about the project through campfire programs and other personal services, park newspaper articles, the wayside exhibit, the brochure that is available at visitor centers, and the traveling exhibit, which is on display at a visitor center when not traveling.

Continuing communication with park neighbors occurs through newspaper articles

Continued on page 19

Red Wolves continued from page 18

and television programs, through the schools and civic club meetings, and at special events in the community, where the traveling exhibit often is displayed and talks given. For example, a booth exhibit is manned and talks presented throughout the annual 5-day Wilderness Wildlife Week in Pigeon Forge, TN. We also include wolf information at teacher workshops, elderhostels, and other sessions at the Great Smoky Mountains Institute at Tremont. The red wolf newsletter now goes to a mailing list of some 350 individuals and organizations.

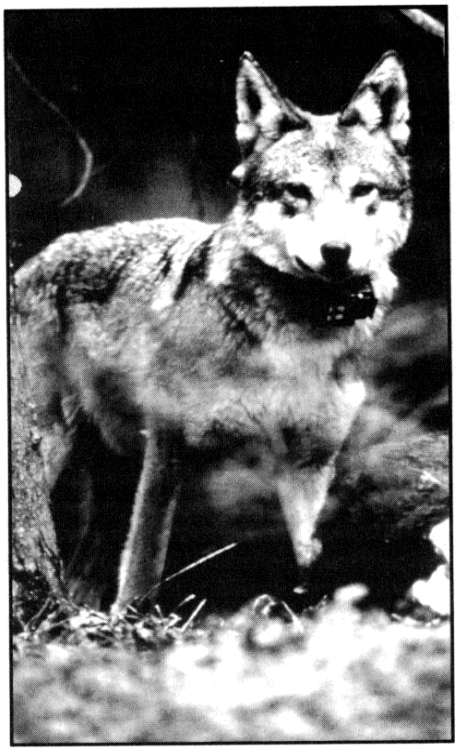
In addition to all the talks and use of media tools, a communication committee meets periodically. Representatives from the park, the USFWS, conservation groups, the Tennessee and North Carolina wildlife agencies, the adjacent USFS national forests and districts, the state and local Farm Bureaus, and others are invited to attend these meetings and react to planned red wolf activities.

Superintendent's Role Important

A very important element in the communication effort from the project's start was the personal interest and involvement of the GRWM superintendent. He made this a top priority, participated in early planning and top-level meetings, chaired communication committee meetings, and was active in major decisions. Many other GRSM staff members, besides the two principals mentioned earlier, have contributed to the communication effort. The NPS regional office has been supportive but not actively involved, leaving this to the park and the USFWS.

SAMAB also has helped, primarily through financial assistance by a member--the TVA--in developing and disseminating the video/poster/teacher's guide package. Station WBIR-TV has been interested and supportive throughout, producing and airing the video and pre-project and ongoing news updates. The NBS affiliate in Asheville, NC also aired "Front Runner." The Great Smoky Mountains Natural History Association (GSMNHA) contracted for production and provided some of the funding for the first red wolf brochure, using money from the Pt. Defiance Zoo in Tacoma, WA. The association also sells art prints and administers a livestock indemnity fund.

We estimate the time spent on the communication effort between 1990 and early 1993 for the NPS was 1.25 work years divided mostly between two people at a total cost of $46,200. Considerable additional time was contributed by three USFWS employees. Out of pocket purchases by the NPS, USFWS, and TVA in the Great Smokies area are estimated at $50,850. Additional contributions include the $24,500 cost to WBIR-TV



One of the red wolves released permanently into the Cades Cove area of Great Smoky Mountains NP in the Fall of 1992.

to produce the Front Runner program; sales from a red wolf print by artist Steve Jackson, and a $25,000 indemnity fund consisting of contributions from the National Fish and Wildlife Foundation, the National Parks and Conservation Association, and the Jackson print sales.

Results and Evaluation

We have been pleased and somewhat surprised at the nearly unanimous public support for the red wolf project. The only groups voicing opposition have been local and state Farm Bureaus on the Tennessee side of the park, and their opposition has been low key. They follow the policy of the National Farm Bureau, which is to oppose any restoration of predators. The wolves have taken some domestic animals in the Cades Cove area at the park, but this has aroused little expressed concern, other than that of the owner of the livestock taken. The owner was compensated from the fund operated by the GSMNHA.

We attribute the success of the education effort to the following:

- Thorough advance planning
- Close targeting of audiences
- Commitment of the park superintendent
- A team approach
- Cooperation and coordination among the participants
- Objective, honest, consistent presentation of scientific information
- Initiation of the program well in advance of the first wolf releases
- Numerous personal contacts with individuals and groups
- Use of a variety of effective media
- Involvement of partners, such as the press, WBIR-TV, SAMAB, and the GRSM Natural History Association

In addition, certain pre-existing conditions probably contributed to the program's success:

(1) the biology of the red wolf, which is smaller than the gray wolf and usually takes smaller prey; (2) the absence of wolves from the southern Appalachians since the turn of the century; (3) the relatively small economic importance of livestock in the area; (4) earlier press coverage of peregrine falcon and otter restoration in the park; and (5) generally good relations of the park with its neighbors.

The success of red wolf restoration in the Smokies now depends on the animals themselves--whether they can live and reproduce in the park environments over the long term. Public interest and support seem assured.

Shelton recently retired as a writer-editor with the Wildlife and Vegetation Division, Washington Office, NPS; Miller is Public Affairs Officer at Great Smoky Mountains NP; Ballentine is an interpreter who works as a liaison with the Resource Management Division, Great Smoky Mountains NP; Henry is the Red Wolf Coordinator, UWFWS, Asheville, NC.

Bill Brown-Denali NP Make A Prize Package

Denali, Symbol of the Alaskan Wild: An Illustrated History of the Denali-Mount McKinley Region, Alaska, by William E. Brown, took first prize in the 1994 NPS publications competition at the Conference of National Park Cooperating Assns. Conference in Williamsburg, VA.

Brown's engaging prose captures the multi-threaded history of Denali NP, from the pioneering spirits that first imagined such a park around majestic Mount McKinley to the government agencies and scientists who prepared the park for the visitors to come. Judges comments included "a beautiful and inviting book," "wonderful historic photos," "an impressive volume of information presented effectively,"

This handsome 224-page soft cover volume is available from the Alaska Natural History Assn., P.O. Box 230, Denali NP, AK 99755 for $19.95, plus postage. The book also is available in hard cover for $29.95.

NPS Paleontologists Present Papers at GSA Conference

By Jeff Selleck

Paleontologists from the NPS and affiliated universities recently shared 35 papers on paleontological research in the national parks as part of the 46th annual Rocky Mountain Section meeting of the Geological Society of America. The meeting was held on May 4 at the Tamarron Resort north of Durango, CO, where some 60 individuals listened in on diverse research presentations that spanned 300 million years in 11 national park system areas. Twenty of the papers, not reviewed here, focused just on Florissant Fossil Beds NM and the surrounding area, and were presented the following day.

Paleontologist and former Petrified Forest NP Chief of Resource Management Vince Santucci coordinated the NPS effort and introduced the sessions. Santucci is deeply proud of his association with the paleontology work going on in the national parks. He speaks enthusiastically of the vast fossil treasures we protect. "The history of life on earth," he says, "is well represented within the units of the national park system. Around 100 of the 370 plus park areas have significant paleontological resources that need our attention and care." Pre-cambrian stromatolites in Glacier NP, early sea organisms in Grand Canyon, dinosaurs in the Colorado Plateau parks, early mammals at John Day and Hagerman Fossil Beds NMs, among others, combine, he asserts, to tell a story of the evolution of life.

Now on staff at the department of parks and recreation at Slippery Rock State University, Pennsylvania, and a part-time professor of paleontology at the University of Pittsburgh, Santucci maintains a strong link with the NPS, currently as a resource management advisor to Grand Canyon NP.

Before introducing the speakers, Santucci recounted the contributions made by Ted Fremd of John Day Fossil Beds and Dan Chure of Dinosaur NM in the gradual evolution of the NPS paleontology program. He explained that just 10 years ago there were few paleontologists within the Service, and archeologists often were the only staff with field excavation experience. When a fossil issue arose, archeologists were the natural choice to deal with it, even though their expertise was cultural sites.

The association between archeologists and fossils in the NP system may have led to the incorrect categorization of fossils as cultural rather than natural resources--an error that Chure and Fremd managed to correct. Also a problem then, managers often viewed the discovery goal of paleontology and the resource protection goal of the parks as incongruent, and denied research projects.

Since those troublesome early days, NPS paleontologists have organized their human resources, as demonstrated by this symposium, and developed a respectable fledgling fossil research and protection program. Critical to this transformation has been educating park managers and staff, as they turn over, about the role and value of paleontology.

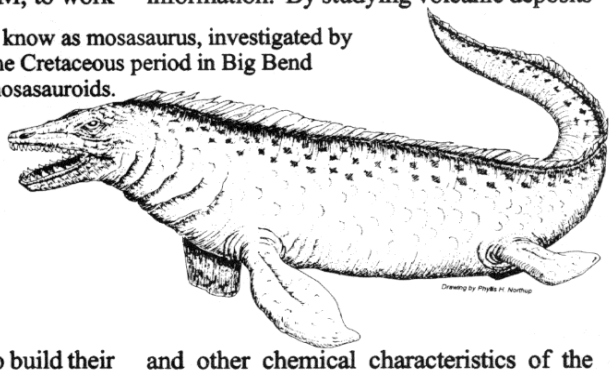
Paleontologists began to publish some of their findings in *Park Science* and in the technical report series of the Natural Resource Publications Office. They held conferences on fossil resources in 1986 at Dinosaur NM, in 1988 at Petrified Forest NP, and two years ago at Fossil Butte NM, to work through the growing pains and to build their track record. In these open exchanges, superintendents, researchers, resource managers, and interpreters, all contributed their perceptions of the value of research and the need for fossil protection.

The culmination of this endeavor and a triumph in Santucci's mind was the adoption of NPS-77, the Natural Resource Management Guidelines, that includes a brief chapter defining how we manage paleontological resources and promoting paleontological research.

Santucci also credits Fossil Butte Supt. David McGinnis for helping legitimize paleontology in the parks by demonstrating the benefits that can be derived from an integrated program of paleontological resource management and research. While the NPS conducts some fossil research, most is done by outside cooperators in the academic world. These partners often fund their projects independently of the NPS and help us understand in their published works the significance of our resources. They and experienced volunteers also can help us set up cyclic prospecting and inventorying and monitoring programs that identify the variety of fossils in an area, determine the relative importance of the fossils, and list the threats they face. Resource managers can then plan excavation priorities. Increased presence in the field also helps us protect the resources, and the information shared aids in interpretation.

Dr. Santucci is pleased with the progress toward building a foundation for paleontology and fossil resource protection in the parks in the past decade, but he sees this as only a beginning. He went to Durango with colleagues from around the park system to continue building the program, to share research findings, and to generate further support.

Many fossil resource parks did not participate in the conference, but those that did demonstrated sophisticated and useful research. Presenters Ted Fremd and Carl Swisher from John Day Fossil Beds discussed techniques for reconstructing the collection localities and subsequent dating of fossils gathered initially with poor locality information. By studying volcanic deposits and other chemical characteristics of the soils and correlating date findings with the distribution of fossil species, they hope to improve their understanding of the time period when some of the early mammals unique to the John Day area lived.



The 30-foot long marine reptile know as mosasaurus, investigated by Gordon Bell, diversified during the Cretaceous period in Big Bend NP evolving into two groups of mosasauroids.

Other studies centered on Petrified Forest NP. Spencer Lucas discussed his bio-stratigraphy work on one of the world's most significant upper Triassic Camian-Norian transition-preserving strata. He inventoried a wealth of fossils including vertebrates, molluscs, fossil pollens, ostracods, coprolites, tetrapods, logs, and other plants. Also interested in the upper Triassic, Tim Demko used a road cut to examine closely associated soil deposits and flora of the Chinle Formation in order to reconstruct the paleogeography of the time. He found that different fossils, while deposited concurrently, may indicate differences in landscape features.

William Davis concentrated on plants, anatomically detailing the preserved reproductive structures seen in plants from the Late Triassic. Finally, Adrian Hunt looked at early to late Triassic dinosaur tracks and fossils in both Petrified Forest NP and Dinosaur NM to learn of their beginnings and why they became so successful. He found that the dinosaurs appear to have evolved in the late Carnian; therapods in Dinosaur NM became more common with time, and the prosauropods began to diversify then.

Reporting on other parks of the Rocky Mountains, Stephen Hasiotis discussed the earliest known fossil evidence of burrowing crayfish at Canyonlands NP, while Jeffrey Eaton described the complexities of verte-

brate paleontology of the Cretaceous rocks in Bryce Canyon NP. James Kirkland detailed his high resolution stratigraphy of the Mancos Shale in Mesa Verde NP, a Cretaceous marine strata rich in fossils. The study was successful as much for its yield of 90 taxa (yet to be described) as for cooperation with the park in working through the necessary archeological clearances along the half-mile trench.

Pat Jablonski, an active caver at Carlsbad Caverns NP, described an easy-to-manage technique for excavating deep cave fossils; Carol Manganaro detailed her study of fossil animals found in Graveyard Cave at Wind Cave NP. Both presenters highlighted the potential of caves to reveal relationships among species trapped within them.

Badlands NP researcher William Wall told of a bio-mechanical change in the jaw structure of oreodonts in response to a late Eocene to Oligocene climate shift that favored grazers over browsers. Robert Hunt reported on his research at Agate Fossil Beds NM, where he excavated the earliest known (Miocene) carnivore den communities on record. Discovered in association with fossils of the bear dog animal group, these chambers measure 10m in length by 2m in width. To close the full day of sessions, Gordon Bell reported on his work in Big Bend NP in dating a fork in the evolutionary tree of the marine reptiles known as monasaurs.

The symposium demonstrated that good things can come to parks that integrate paleontology into their programs. Most of the presentations detailed significant advances in our understanding of life on earth from research conducted just within NP units. But as Santucci commented later, this kind of gathering is just one component needed to further paleontology in the parks. Also important is to develop partnerships with universities, use volunteers to carry out projects, train resource protection rangers to identify fossils at risk, encourage interpreters to share the stories in the rocks, and motivate parks to participate in paleontology information exchanges.

Those who missed this discussion of paleontology within the parks have another opportunity to participate when the fourth conference on fossil resources is held in Colorado Springs this October 31 to November 4. The conference has broadened its scope to include fossil resources on all public lands and the list of cooperators is now made up of the BLM, USFS, USGS, and the Colorado State Lands Board, along with the sponsoring Florissant Fossil Beds NM. Contact Maggie Johnston for further information at PO Box 185, Florissant, CO 80816; 719/ 7483253.

Selleck is the incoming editor of Park Science

The National Biological Survey– A Perspective From the Past

By R. Gerald Wright

The administration of Franklin Roosevelt was a heady time for those individuals who believed that the federal government should play a major role in the socio-economic affairs of the country. Conservation of the nation's natural and cultural resources was one of those roles. Harold Ickes, the Secretary of the Interior under this administration, firmly believed that this goal could best be accomplished through the creation of a Department of Conservation--an agency that would include the Forest Service, National Park Service, Biological Survey, Bureau of Fisheries, and the Grazing Division.

This concept had at least the tacit approval if not the strong endorsement of the President. However, because of intense Congressional opposition against moving the Forest Service out of the Department of Agriculture, the creation of this new department was not realized -- although over the years, the concept has retained its allure and has surfaced time and again under subsequent administrations.

In lieu of achieving this larger goal, Ickes was offered the more modest prize of taking over the administration of the Bureau of Biological Survey, which was transferred from Agriculture to Interior in 1940. The Biological Survey was an agency with a long and illustrious history. Originally established as the division of Economic Ornithology and Mammalogy in 1885 and headed by the famous biologist C. Hart Merriam, its name was changed to the Bureau of Biological Survey in 1905 to better reflect Merriam's interests . . . that was as the natural history agency of the government, with much of its early work being devoted to defining the geographical distribution of animals and plants in various regions of the country. In subsequent years, however, economic and utilitarian factors exerted an ever greater influence on the agency and its primary roles became predator control and the management of wildlife refuges and migratory waterfowl.

With the transfer of the Biological Survey to Interior, Ickes sought to carry out his goal for a Department of Conservation on a smaller scale by consolidating all federal research personnel in the department (primarily wildlife researchers) in the Biological Survey. This involved the transfer of the wildlife biologists from the National Park Service and the Grazing Division, and the biologists in the Bureau of Fisheries to the Biological Survey.

This expanded Biological Survey had many similarities to the present National Biological Survey. Among them were debates over how well NPS research needs would be served by biologists that now worked for another agency. Although an "Office of National Park Wildlife" was established within the Biological Survey which housed the transferred NPS biologists, it was, as Lowell Sumner (one of the transferred biologists) told me in an interview: "...difficult to know how to address national park concerns in a bureau whose goals were set by ... predator control and sport hunting [interests]." Also, as today, the number of NPS biologists transferred to the expanded agency was small in comparison with the number of biologists who already were a part of the existing Biological Survey.

The expanded Biological Survey proved to be short-lived because, after only a few months, Ickes decided to merge the Biological Survey with the Bureau of Fisheries to create the Fish and Wildlife Service. So in 1947, seven years after it was established, the Office of National Park Wildlife, then in the Fish and Wildlife Service, was abolished and the scientists in that office were transferred back to the NPS, where it took many years to build a credible natural science program.

Wright is a wildlife research scientist and Unit Leaders of the NPS CPSU at U/ID, Moscow, ID.

Suggested Readings

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Reconstructing Climate Data in Parallel Watersheds Provides Useful Data on Muir Woods

By Robyn Myers

While I was a graduate student and also a former ranger at Muir Woods National Monument (NM), a class assignment provided me the opportunity to reconstruct the Muir Woods precipitation history as part of a dendroclimatic study. The tree ring analysis itself was not significant, but the precipitation reconstruction provided some interesting and useful data.

Muir Woods NM has kept precipitation data only since 1948. However, a nearby, and parallel, watershed in Kentfield has instrumental precipitation data going back to 1888. Because the two watersheds exhibit similar precipitation patterns, I was able to reconstruct the precipitation record for Muir Woods for the years prior to 1948 based on the instrumental record for Kentfield.

Climatic data series generally are based on instrumental climatic measurements, but also may be based on historical documents and paleo-climatic reconstructions from tree rings, ice cores, and sediment cores. These data all vary in quality, geographic coverage and time resolution, as well as the total length of the record (Fritts 1991). According to Fritts, instrumental data have the highest quality and resolution, but in North America they seldom span the last 200 years. The primary goal in collecting tree rings for dendroclimatic analysis is "to obtain the longest and clearest record of past climatic variations," Fritts notes. However, he adds that ring width measurements do not always contain information on climate. It is for this reason that other methods of obtaining climate history often are used.

For a Muir Woods dendroclimatic study (Myers 1993), climatological data for the Muir Woods area were obtained from several sources. Muir Woods itself has kept climatic records and reported them for inclusion in the California State Climatological Data books since 1948. On request, Muir Woods sent me the seasonal rainfall from 1948 to the present. I obtained the annual rainfall totals from the State Climatological data books. Redwood Creek in Muir Woods is one of several watersheds originating on Mt. Tamalpais. Muir Woods' rainfall is consistently greater and has a different pattern from that of the County weather station at the Marin County Civic Center in San Rafael. Therefore, due to the differing weather patterns, the County weather data were not appropriate for comparison and were not considered.

However, a watershed near Redwood Creek has a weather recording station that has

Figure 1.

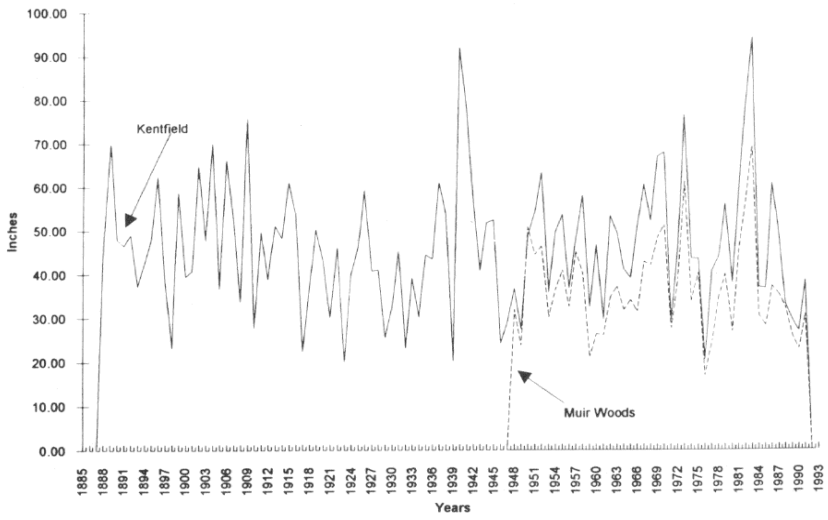
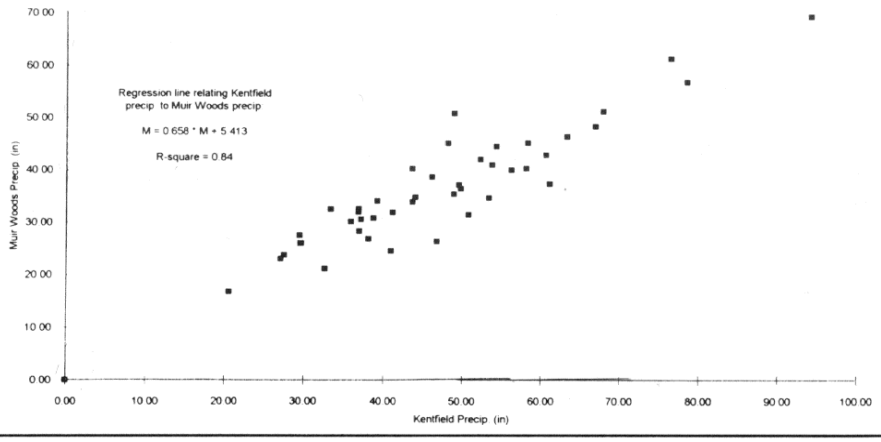


Figure 2.

lag	CCF	lag	CCF	lag	CCF	lag	CCF
-43	.0088	-42	.0372	-41	.0535	-40	.0278
-39	-.0153	-38	-.0303	-37	.0028	-36	.0303
-35	-.0367	-34	-.1204	-33	-.0878	-32	.0226
-31	.1409	-30	.0125	-29	.0565	-28	.0933
-27	.0297	-26	-.0311	-25	-.0094	-24	-.0952
-23	-.0133	-22	-.1711	-21	-.0613	-20	-.1003
-19	-.0432	-18	-.0250	-17	-.0330	-16	.0436
-15	.1750	-14	.0649	-13	.2275	-12	.0353
-11	-.0176	-10	.0989	-9	-.0767	-8	-.2329
-7	-.3854	-6	-.1269	-5	.0235	-4	.0081
-3	-.0479	-2	-.0802	-1	.2360	0	**.9168**
1	.2158	2	-.0973	3	-.1065	4	.0783
5	-.0498	6	-.3102	7	-.3897	8	-.1196
9	-.0915	10	.1144	11	-.0208	12	.1578
13	.2427	14	.0832	15	.0725	16	.0703
17	-.0126	18	-.0079	19	-.0512	20	-.1396
21	-.1904	22	-.1318	23	-.0496	24	-.1087
25	.0359	26	-.0043	27	.0278	28	.0877
29	.1103	30	.0420	31	.1829	32	.0935
33	-.0361	34	-.1318	35	-.0102	36	.0473
37	-.0371	38	-.0811	39	-.0465	40	-.0091
41	.0314	42	.0294	43	.0058		

95% significance is .2955

Figure 3.



maintained precipitation records dating farther back. The Kentfield weather station (whose historical and current location remains a mystery, even after telephone inquiries throughout the county!) has maintained precipitation data back to 1888. The U/CA-Davis had California State Climatological Data books with Kentfield data back to 1907. Data from 1888-1906 were obtained from the State Climatologist at the State Department of Water Resources, Division of Flood Management, in Sacramento.

The Kentfield area in Marin county is another of the primary watersheds of Mt. Tamalpais. Kentfield has the not undeserved reputation of being the "wettest" place in the County in terms of annual rainfall. Despite differences in the rainfall amounts between Kentfield and Muir Woods, there was a strong corresponsdence between the patterns of the two precipitation records. When a strong correspondence is present it is possible to reconstruct reasonable estimates for the missing data in the parallel watershed. The Muir Woods precipitation from 1888 to 1948 was reconstructed based on the Kentfield rainfall data.

The following hypotheses were tested using climatological data from Muir Woods and Kentfield weather reporting stations:

H1: Muir Woods rainfall is directly correlated to Kentfield rainfall.

H1a: There will be a strong positive cross-correlation function.

Kentfield (1988-1991) and Muir Woods (1948-1991) annual precipitation (instrumental) records were plotted for years and inches of precipitation (Fig. 1). The instrumental precipitation records for Kentfield (1948-1991) and for Muir Woods (1948-1991) show a reasonably close correspondence, with Kentfield generally having the greater rainfall.

The cross correlation function between the Kentfield and Muir Woods instrumental precipitation was calculated (Fig. 2) using ASTSA for Windows (Shumway 1992). The data show a strong positive cross correlation at lag 0 of .9168, where 95 percent significance is .2955. The statistical correlation for Kentfield vs. Muir Woods precipitation was plotted in Excel for Windows (Fig. 3). As expected, the Kentfield instrumental precipitation data (1948-1991) and the Muir Woods data (1948-1991) show a very close correlation, with an R2=0.84. Considering they are watersheds on the same side of Mt. Tamalapais, experiencing the same weather patterns, this high correlation is not surprising.

The Kentfield vs. Muir Woods precipitation regression statistics were calculated in Excel for Windows (Fig. 4). As discussed above, the regression statistics for the instrumental precipitation data of Kentfield and Muir Woods show a very high correlation. These statistics were used in the graph shown as Figure 5. Data for the missing Muir Woods years (1888-1947) were reconstructed, using the formula $M = 0.658 * M + 5.413$ and the Kentfield instrumental data for those years. Muir Woods precipitation was reconstructed for the years 1888-1947. Both the reconstructed and instrumental precipitation data using the data from the regression statistics above were plotted (Fig. 5). While these are only estimates, they are a best guess based on the high R2.

Conclusions

It is clear that Muir Woods rainfall is directly correlated to Kentfield rainfall, supporting hypothesis H1. The time series analysis confirmed this with a strong positive cross-correlation function, supporting hypothesis H1a. The reconstructed precipitation data for Muir Woods from 1888 to 1947 could be useful in future dendrochronological analyses.

This technique may prove useful in other locations when weather station instrumental data is available from parallel watersheds. Like tree ring analysis itself, climate data patterns can be linked by matching the patterns. Where instrumental data from the parallel watersheds show a strong correlation, extrapolation of missing data from one watershed to the other appears to be a reliable analog.

Myers is a PhD candidate in the Graduate Group in Ecology at U/CA-Davis. She is cooperative education research scientist trainee in the Ecosystem Science and Technology Branch of the NASA Ames Research Center, Moffett Field, CA.

Figure 4.

Regression Statistics

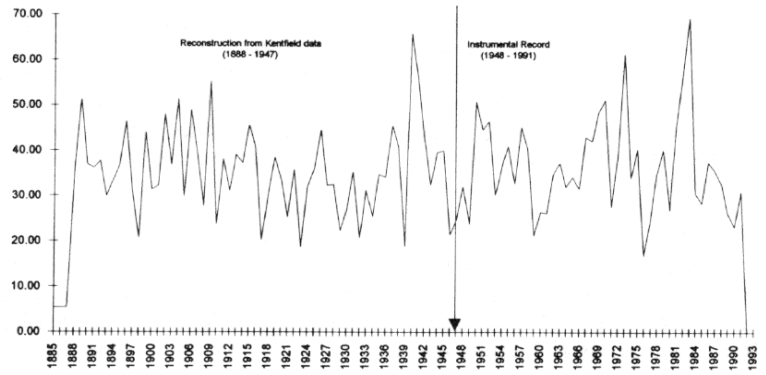
Multiple R	0.916839119
R Square	0.84059397
Adjusted R Square	0.836798588
Standard Error	4.367636119
Observations	44

Analysis of Variance

	df	Sum of Squares	Mean Square	F	Significance F
Regression	1	4224.970796	4224.970796	221.48	2.3778E-18
Residual	42	801.2023013	19.07624527		
Total	43	5026.173098			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	5.413155216	2.200779753	2.459653316	0.018	0.97180046	9.85450997
x1	0.65835101	0.044237655	14.88214072	1E-18	0.56907578	0.74762624

Figure 5.



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Gap Analysis: Another Look

By Kathy Jope

The winter 1994 issue of *Park Science* carried a thought-provoking article by Machlis et al., which extends the concept of gap analysis described by Scott et al. (1991, 1993) to its social dimension.

Gap analysis has been advanced as a means of identifying "unprotected yet critical areas of biodiversity." Through gap analysis, it is posited, we will be able to protect areas that are crucial to the conservation of biodiversity.

Such an approach is attractive, since it presents an objective means of identifying areas to be protected. However, it is based on two fundamental assumptions, which need to be critically examined. In discussing them, my intent is not to undermine the concept of gap analysis, but to encourage critical thought about it.

The first assumption of gap analysis is that a viable population of each rare species can be contained within the delineated reserve. This may be possible for resident species, but it is more problematic for species that require widely separate summer and winter range, not to mention highly migratory species such as many shorebirds and songbirds. For species to persist over the long run, provision must also be made for changing landscapes and recolonization following disturbance.

Ecosystem Linkages

This leads to the important point that gap analysis focuses not on ecosystems but on aggregations of individual species. An ecosystem is far more than simply an aggregation of species. The essence of an ecosystem is the flows and processes, and the *interrelationships* among the myriad species. It is critical to recognize that gap analysis is not a method that will necessarily conserve ecosystems. There is no guarantee that a reserve designed through gap analysis will conserve the vital linkages and interrelationships of the intact ecosystem.

The second assumption in gap analysis is that species and, presumably, the ecosystems of which they are part, can be effectively protected in a reserve. One has only to look at the results of our efforts to conserve the integrity of park ecosystems to see that the validity of this assumption is debatable. Reserves designed through gap analysis are a valuable part of the conservation agenda, serving valid roles as biological insurance policies and in their contribution to diversity of management. However, reserves alone are not sufficient to conserve biodiversity if they are surrounded by a landscape that is hostile to life.

In delineating reserves to conserve biodiversity, gap analysis accepts a paradigm of dualism, a paradigm that considers people as separate from the natural world, and human-use areas as separate from reserves. Human use of resources and land are seen as incompatible with nature and the conservation of biodiversity. At its extreme, such a dualistic approach does not recognize any substantive link between the well-being of people and the well-being of the environment. In its more moderate version, it focuses conservation efforts on delineating preserves that will be protected from human activities that will continue unabated beyond the preserve boundaries.

Impact or Interaction?

We have too easily accepted the premise that human activities are inherently destructive. This is even reflected in our "Environmental ***Impact*** Statements." In striving to minimize the impact of human activities, we imply there will inevitably be some level of impact. Need this be so?

As Scott et al. (1993) noted briefly, there is an alternative paradigm, one that rejects the dualistic approach and instead views people as inextricably linked with the earth. According to this paradigm, wherever we go we are part of an ecosystem. In the air we breathe, in the water we drink, in our interactions with plants, animals, insects, even soil microorganisms, we are linked with the ecosystem around us. We take responsibility for the direct and indirect effects of our activities, not just in a few reserves, but everywhere, in everything we do.

This alternative to dualism might be considered an "ecocsystem" approach. Its focus is on interrelationships, flows, and processes. Consider how our approach would be different if we consciously recognized our connectedness--the interrelationships between ourselves and the ecosystem in which we live and work.

In discussing the social dimensions of gap analysis, Machlis et al. (1994) cited "demographic change" and "monetary wealth and capital" as two factors that contribute to impacts on biodiversity. However, these two factors do not inherently lead to impacts. Rather, the impacts stem from the level of resource consumption that we have considered acceptable in our society and which varies with demography and wealth. Similarly, industrial activities and land use do not inherently lead to ecosytstem impacts. It is the <u>way</u> of living and doing business that needs to be redesigned.

What Goes Around Comes Around

Viewing people as connected with the ecosystem, we would look differently at the effects of our activities on the ecosystem. We would not be so accepting of their destructiveness. **It is true that life and death are fundamental ecosystem processes. But what other species in an ecosystem destroys not only life, but the very life-giving potential of the system?** Humans do, through release of toxic materials, extinction of species, destruction of fertile soil, and many other actions. Seeing ourselves as members of the community of life, we would be more likely to recognize that when we harm the ecosystem, we harm ourselves. We need to become more responsible members of our community.

One way we can do this is to work with, rather than against, ecosystem processes--to strive to nurture the ecosystem around us, its diversity of life, and its life-giving capability. In business there is a growing field known as industrial ecology. Industrial ecology explores ways in which industrial processes can be designed using ecosystems as a model. Processes in ecosystems tend to occur as loops and cycles rather than the linear path from the source to the dump that characterizes so many of our industrial processes. In an ecosystem, the by-products of one process are the raw materials for another, and there is no such thing as effluent.

How would our operations in national parks differ if we were to adopt an approach such as this--if we use ecosystems as our model, worked with, rather than against, ecosystem processes, and fostered a sense of connection between people and the earth? Consider how we would design visitor centers, roads, and housing areas if we viewed people and our infrastructure as a nurturing component of the ecosystem. Consider how we would design a facility if, for example, we saw ourselves not as using water, but only borrowing it. Consider how we would design the visitor experience if a common thread running through it was to foster our sense of connection with the world around us.

A Society in Transition?

Adopting such a paradigm is not as unrealistic as it may seem. Things change. Society's values and behavior change. Our old way of doing business and the way we related to the environment simply is not working anymore, and the results are becoming less and less acceptable. More and more people, and more and more communities, are recognizing that there is a different way. There is a perception that society is entering a transition, with increased recognition of the difference between needs and wants, and greater willingness to forego immediate gratification in the interest of long-term well-being.

The NPS has a choice: We can either follow along behind society in these changes, or we can move to the forefront as leaders in environmental stewardship. We can support a dualistic paradigm that has not been re-

Continued on page 25

Jim Larson Retires As PNR Chief Scientist

Jim Larson, who retired May 3, 1994 as Pacific Northwest Regional Chief Scientist, is laying down the capably held reins of responsibility for a life of reading, biking, contemplating, and generally enjoying the good things he has had to squeeze into the cracks of life up till now.

Larson began his Park Service career in 1959 as a ranger in Mount McKinley (now Denali) NP. He served as park naturalist at Rocky Mountain and Haleakala NPs. In 1967, Larson joined the Office of Natural Science Studies under NPS Chief Scientist Robert Linn in Washington, DC. Since then, he has served as Regional Chief Scientist in the Southeast, Midwest, Alaska, and Pacific Northwest Regions. He began his PNR tour of duty in 1983.

It is the hope of this editor, who also is retiring, that Jim will continue to read extensively in the science and resource management field, and will share his readings with new *Park Science* editor Jeff Sellick, as he has done so generously over so many years to the benefit of this editor and Information Crossfile readers.

Larson has been a mainstay of the *Park Science* editorial board, holding the post of chairman continuously since the board was formed in 1983. He will be missed.

* * *

Jope Appointed Acting

Kathy Jope, PNR Chief of Natural Resource Management, has been named Acting Chief Scientist in an interim action and will carry on the job of developing a working partnership with the National Biological Survey as it staffs its new eco-regional office in Seattle. Shirley Clark will continue as Assistant Regional Chief Scientist.

Meetings of Interest

1994

Oct. 22-26 **NATIONAL SYMPOSIUM ON URBAN WILDLIFE** at Seattle-Bellevue, WA Embassy Suites Hotel; a 2-day local workshop will precede the national focus on the needs of wildlife, advice for conservation, and measuring progress toward meeting the needs of both people and wildlife in metropolitan environments. Sponsored by the National Institute for Urban Wildlife; contact Dr. Lowell W. Adams, NIUW, 10921 Trotting Ridge Way, Columbia, MD 21044; (301)596-3311.

Oct. 24-27 **GEOLOGIC SOCIETY OF AMERICA**, Seattle, WA; for program, registration, and lodging information, call (303)447-2020 or 1-800-472-1988.

Oct 26-29 **NATIONAL WATCHABLE WILDLIFE CONFERENCE**, Burlington VT; Theme: "Take a Closer Look" — The public and private sectors will join experts to find effective ways to make watchable wildlife work to conserve biodiversity. Contact National Watchable Wildlife Conference, 607 Lincolnway West, Mishawaka, IN 46544.

Oct. 31-Nov. 4 **FOURTH CONFERENCE ON FOSSIL RESOURCES**, Colorado Springs, CO; contact Maggie Johnston, PO Box 185, Florissant, CO 80816: (719)748-3252.

NOV. 14-18 **SIXTH NATIONAL INTERAGENCY WILDERNESS CONFERENCE**—"The Spirit Lives: Reflections and Visions on the 30th Anniversary of the Wilderness Act," at the Sweeney Convention Center, Santa Fe, NM; contact Peter Keller, Rm. 3230, NPS—Park Planning; 1849 C St. NW, Washington, D.C. 20240.

1995

Apr. 17-21 **EIGHTH CONFERENCE ON RESEARCH AND RESOURCE MANAGEMENT IN PARKS AND ON PUBLIC LANDS**, sponsored by The George Wright Society; Portland, OR. Theme: "Sustainable Society and Protected Areas—Challenges and Issues for the Perpetuation of Cultural and Natural Resources." Registration information will not be available till September 1994, but those interested in attending should notify at once The George Wright Society, PO Box 65, Hancock, MI 49930-0065

Parsons Named Director of Wilderness Institute

The Aldo Leopold Wilderness Institute (see *Park Science* 13:3, p 12) has a new director: David J. Parsons, formerly NPS Research Scientist at Sequoia/Kings Canyon NPs. The Institute is located in the Research branch of the USFS but physically situated on the campus of U/MT at Missoula.

The new venture is designed to bridge the gap between science and management as applied to the broad concept of wilderness management. It will focus on ecological as well as visitor impact and social phenomena. "I hope," Parsons said, "to use the Institute as a forum to continue my efforts to improve the quality of science available to managers and policy makers in furthering the long-term understanding and protection of wilderness, parks, and other natural areas."

The Institute is an interagency effort, with memoranda of understanding among the USFS, NPS, USFWS, BLM, and NBS.

Gap Analysis continued from page 24

soundingly successful in the past and whose prognosis for long-term success is dim, or we can embrace our role as responsible and respectful members of our diverse ecosystem.

There is no difference between you and the Earth. When you learn to read the Earth, you learn to read yourself. When you heal the Earth, you heal yourself.

Doreen Mahoney
Skagit Systems Cooperative
(Native American Tribal Organization)

Jope is Chief, Natural Resources, NPS Pacific Northwest Region, Seattle, WA 98104

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Machlis, Gary E., Deborah J. Forester, and J.E. McKendry. 1994. Gap analysis and national parks: Adding the socio-economic dimension. *Park Science* 14(1):6-10.

Scott, J.M., B. Csuti, K. Smith, J.E. Estes, and S. Caicco. 1991. Gap analysis of species richness and vegetation cover: An integrated conservation strategy, pp. 282-297 *in* K.A. Kohm, ed. Balancing on the brink of extinction. Island Press, Washington, D.C.

Scott, J.M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D.'Erchia, T.C. Edwards, Jr., J. Ulliman, and R.G. Wright. 1993. Gap Analysis: A geographic approach to protection of biological diversity. Wildlife Monograph 123. 41pp.

Mihalic, Johnson and Loope Win 1993 Natural Resources Awards

The Director's Natural Resource Awards for 1993 were presented at the March 22 Regional Directors' Meeting to Dave Mihalic, Mammoth Cave NP Superintendent; Beth Johnson, Chief of Research and Resource Planning at Delaware Water Gap NRA (and a new member of the **Park Science** editorial board), and Lloyd Loope, Conservation Biologist at Haleakala NP, (now with the National Biological Survey).

Book Review

Fire Ecology of Pacific Northwest Forests by James K. Agee. Island Press. 1993, Box 7, Covelo, CA 95428.

"As long as plant biomass had been present on the earth," Jim Agee writes in his opening chapter, "lightning has ignited fires, and the myriad ecological effects have been repeated time and again." This comprehensive and well written book could not come at a better time.

Among the lessons learned over the past few years about how to and how not to manage forest ecosystems, one of the more important has been the critical need to understand and account for fire when developing strategies for protecting species and restoring and maintaining ecosystem health. Like the fierce Hindu goddess, Kali, who carries a bloody dagger in one hand while blessing and protecting with another, fire both destroys and renews, and in this complex process plays a central role in maintaining ecosystem health.

The importance of fire in shaping forests of western North America is evidenced by the wide array of adaptations evolved by trees and other plants to either survive or quickly recover from fire: thick bark, the ability to sprout from roots, serotinous cones, seeds that lie buried for hundreds of years to germinate only when sufficiently heated. My colleagues and I have hypothesized that the ubiquity yet uncertainty of wildfire has catalyzed the evolution of cooperative relationships among plant species. In the west, we have learned to our chagrin that eliminating the frequent, gentle fires that historically burned through dry forests has led to unforeseen and unwanted consequences; native insects and pathogens have become more aggressive and forests more susceptible to drought, and rather than eliminating fire the stage has been set for fires that are significantly more widespread and destructive than those that occurred in the past.

The book is divided into 13 chapters. The first six chapters deal with individual forest zones, including Sitka spruce, redwood and hemlock; Pacific silver fir and red fir forests; subalpine forests; mixed conifer and mixed evergreen associations; ponderosa and lodgepole pines; and oak and juniper woodlands. For each forest type, Agee discusses fire regimes, stand development patterns following fire, and management implications. The final chapter addresses the future role of fire in ecosystem management, park and wilderness management, species conservation, and forest health, and briefly touches on how fire regimes might be altered by global climate change.

The Ecology of Coexistence

The Feb. 18, 1994 issue of Science contains a book review by James H. Brown at the U/NM biology department of Species Diversity in Ecological Communities: Historical and Geographical Perspectives, Robert E. Ricklefs and Dolph Schluter, editors; University of Chicago Press, 1994 ($32.50). The review, which appears on pp 995-6, applauds the work as evidence that "contemporary ecology is built upon a strong empirical and theoretical foundation."

Brown's review opens with a reference to G.E. Hutchinson's 1959 essay, "Homage to Santa Rosalia, or why are there so many kinds of animals?" and observes that "not only did Hutchinson focus attention on the ecological processes that enable species to coexist in the same environment, he was remarkably prescient: most of the processes he hypothesized to be important in regulating diversity are still the subjects of major research programs today."

And now, 35 years after Hutchinson's 14-page essay, "we have a wonderful 414-page volume summarizing the extent to which modern ecology has succeeded in explaining biological diversity." Editors Ricklefs and Schluter have put together 30 chapters by 50 authors from 10 countries and provided "an exceptionally broad and deep representation of the current state of the science. There is such a wealth of ideas and information that in my department we plan to spend the entire coming semester of our journal club on the volume."

Two important things the book does, says Brown. "First, it shows how much we have learned about the organization and diversity of ecological communities in the last 35 years ... (and second) it makes clear that modern ecology still has no general, satisfying answer to Hutchinson's question." No consensus yet exists for explaining the most pervasive patterns of biological diversity, but the book illustrates this well by two chapters (Rosenzweig and Abramsky; Wright *et al*) that discuss the relationship between diversity and productivity and reach quite different conclusions.

In recognition that traditional ecological studies of local patterns and processes are inadequate to understanding diversity, the editors include chapters by biogeographers, paleobiologists, and systematists, giving the book "an exceptional breadth of data, theory, and viewpoint."

Brown's enthusiasm comes through strongly in his concluding paragraph: "Many scientists in other disciplines still think of ecology as old-fashioned natural history or as comparable in rigor to a social science. Some ecologists, both young and old, are hypercritical and discouraged, rather than optimistic and excited, about the status and prospects of their discipline. I wish that all these skeptics would read this book. It is a testament to how far ecology has come in the last 35 years and to the great challenges that still lie ahead."

The word that comes most often to mind as I think about this book is "scholarly"—however, I hasten to add that does not translate into boring or unreadable. Quite the contrary, the book is readable and packed with good information. It is thoroughly researched and documented (close to 1,000 references), and includes numerous graphs and photos (including some interesting historical shots showing changes in stand structure following fire exclusion).

Though the book deals with the Pacific Northwest, Agee does not hesitate to pull relevant information from other regions, thereby avoiding a feel of provincialism. There are a few issues I would like to have seen receive more space (e.g. the importance of sprouting plants in stabilizing soils, the protective role of some hardwood species in conifer forests). However, that should be considered minor criticism; I know of no other work on the ecology of fire, from any region, that comes close to being as comprehensive and far-ranging in the topics it covers.

I recommend it highly for professional land managers, academics, environmentalists, and anyone with interest in forest ecosystems.

David A. Perry

Perry is a professor of forest science at Oregon State University, Corvallis.

Regional Highlights

Pacific Northwest

The Rivers, Trails and Conservation Assistance (RTCA) program in the Region is assisting the Department of Agriculture to develop USFWS/NPS cooperative partnership projects with outside groups in four pilot cities--Seattle, Atlanta, Chicago, and New York. RTCA held its first workshop on February 17--discussion among 50 Seattle and county (King, Pierce, and Snohomish) officials, and conservation leaders from all over the region. Since then, RTCA has worked with organizing groups to develop and identify partnership goals and potential project areas; to define the organizing framework of the Partnership; to select a full-time Partnership coordinator, and to set a schedule of implementation for the rest of the fiscal year.

Director Kennedy has made a formal commitment of NPS staff through RTCA to the development of this concept, and the RTCA staff will continue to participate in its development and implementation.

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RTCA and the Soil Conservation Service are working with the Kalispel Reservation in northeastern Washington for the use and protection of the Reservation. The Kalispels are a small tribe interested in habitat restoration and resource management, and in the development of recreation/interpretive opportunities that could generate revenue. The reservation, which possesses significant wildlife habitat and a rich abundance of water fowl, mammals, and rare riparian forests, is located in a scenic but poor part of the state and has untapped resources for tourism. The plan will provide proposals for resource conservation and restoration, interpretation, recreation, and appropriate economic enterprises.

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RTCA is helping the Trust for Public Lands and the Evergreen Alliance write and produce the "Conservation Toolbox," a manual for communities to use in developing strategies for acquiring and/or protecting open space and other significant local, natural, cultural, or recreational resources. They are investigating development of electronic products to accompany the manual, which will be available for distribution by September.

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Ruth Anderson attended the annual long distance trail managers meeting in Tallahassee, FL in February. Strategic planning for long distance trail management had been initiated at the last annual meeting in Tucson, AZ, and the improved focus has become particularly important in light of various reorganization plans. Other initiatives discussed included multi-objective resource management, GIS, cultural landscape identification, and urban initiatives.

The Pacific Northwest Region's proposal to conduct a cultural landscape inventory and study along the Oregon National Historic Trail may become a demonstration project for other Regions.

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Bill Walters and Kathy Jope are working with the Regional Interagency Executive Committee toward implementation of the President's Forest Plan. Supporting the Executive Committee are 18 working groups addressing such topics as watershed analysis, watershed restoration, endangered species consultation, coordination with other intergovernmental efforts, adaptive management, strategic research planning and coordination, monitoring, and public information.

NPS personnel from Crater Lake, Mount Rainier, North Cascades, Olympic, Redwood, and the PNR Office, are participating on 14 of the working groups. The Committee has approved delineation of 12 multi-watershed "provinces" in the area extending from the Canadian border to Muir Woods in California.

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Marsha Davis, geologist in the Regional Office, met in Menlo Park, CA with researchers from the USGS, Washington DNR, and Oregon State University to discuss the Cascadia 2000 research program, the results of which will have significant implications for all the parks in western Oregon and Washington.

Beginning in 1994, the USGS, through its Deep Continental Studies Program, will conduct geophysical experiments in southwestern Washington to study the geometry of plate boundaries, their interactions, and the deformation and mobility in the continental rocks. Tectonic research can yield information about deeper parts of the earth that cannot be gained by surface geologic mapping.

Purpose of the Menlo Park meeting was to discuss possible locations for an east-west seismic survey line from offshore to the eastern margin of the Cascade Range. Part of the research involves seismic refraction and wide-angle reflection surveys. The proposed seismic survey will fall between Mount Rainier and Mount St. Helens. Exact location will be based upon proximity to geological anomalies that would interfere with the data, accessibility by road, and permitting approval by WA/DNR.

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In recognition of his contributions to the university community, Dr. H. Gregory McDonald, NPS paleontologist at Hagerman Fossil Beds National Monument, has been appointed an affiliate faculty member in the ID/State University department of geology. Dr. McDonald is developing the monument's research programs and fossil resource inventory criteria.

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PNR Chief of Natural Resources (and Acting Chief Scientist) Kathy Jope has accepted an invitation to serve on the Advisory Board for the Division of Ecosystem Science and Conservation in the U/WA College of Forestry. The advisory board will help devise the curriculum for the "Wildlife" and the "Conservation of Wildland Resources" majors, as well as address other needs such as continuing education and potential opportunities for students to work on natural resource surveys and other park projects.

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Michael Tollefson, Associate Regional Director, represented the PNR at the dedication of the Sterling Munro Trail at North Cascades NPS Complex on May 28, as part of the celebration of National Parks Week. Supt. William F. Paleck, speaking at the Henry M. Jackson Visitor Center, reminded guests of the tremendous contributions to natural resource protection by Senator Jackson and his administrative assistant, Munro. The results of their work, Tollefson told the assemblage, "benefited the NPS and all Americans." Among those significant accomplishments are the Wilderness Act, the Redwoods NP Act, the North Cascades NP Act, and the National Environmental Policy Act.

Tollefson cited the Service's primary responsibility--protection of park resources, and credited Jackson and Munro for breaking important ground in this direction. "Ecosystem management must be our proactive style," he said. "We must be committed to increasing our understanding of how entire ecosystems interrelate and how other agencies and organizations manage their lands so we can better protect park resources."

Western Region

David M. Graber, Research Scientist at Sequoia and Kings Canyon NPs, (now with the National Biological Survey at the Sequoia/Kings Canyon NPs Field Station), is the author of a chapter in **Nature and Reality: Critiques of Postmodernism**

Regional Highlights

Deconstruction, edited by Michael E. Soule and Gary Lease and published early this year by Island Press, Washington, DC.

Graber's chapter is entitled "Resolute Biocentrism: Managing for Wildness in National Parks." In seven packed pages, he examines the concept of "wildness," the attempts to perpetuate of native ecosystem elements and processes, the largely unacknowledged landscape alterations that occurred as a result of former aborigine activities, the on-going alterations that are taking place in the no-man's land of it's-not-my-job, man, and the biodiversity problems thereunto pertaining.

In a provocative wind-up, Graber asks "What are parks for?" He doesn't so much answer as suggest answers, but he does suggest that "Whatever the 'rightness' or 'wrongness' of the civilization we continue to invent, wild nature and national parks represent--however imperfectly and however dependent upon our continued care--ecological anchors to our own and the planet's past."

Alaska Region

The National Park Stewardship Association (NPSA) was organized recently to represent the concerns of NPS resource management professionals. Membership is open to persons interested in the application of scientific principles in the monitoring and management of national park natural resources.

The group provides a forum (meetings and newsletter--first edition has been printed) for the discussion and information exchange of NPS policies and practices related to the science of resource management. The newsletter includes a viewpoint section that offers pros and cons of controversial issues. Overall, the aim is to support leadership and fellowship among members.

New of the organization comes from Gary Vequist, who gives the following address for copies of the newsletter and membership information: NPSA; 1902 N. Salem Dr.; Anchorage, AK 99508.

Southeast Region

The regional office has begun a water resources monitoring program to provide small parks with a cost-effective, self-sustaining mechanism to acquire and interpret sound aquatic resources data. The program, designed and directed by the SER Water Resources Coordinator, aids in developing baseline aquatic biological and water quality information. It also addresses threats to water resources.

The monitoring program at Kennesaw Mountain National Battlefield Park in Georgia is the prototype. King's Mountain National Military Park in South Carolina and Shiloh National Military Park in Tennessee have instituted similar programs. More parks will follow as funding becomes available. A detailed account of this program will be submitted this year to the *Highlights of Natural Resource Management* publication. For information, contact Brendhan Zubricki at 404/331-4916.

* * *

A regional resource management workshop was held in April in Chattanooga, TN and attended by representatives of 22 parks. Two days of the workshop focused on exotic vegetation management. Highlights included presentations by NBS Research Center Directors Milton Friend and Robert E. Stewart, and Asst. Center Director Nick Fufmicelli, and presentations by U.S. Congress Office of Technology Assessment Project Director Phyllis Windle and by Randy Westbrooks of APHIS. Updates were provided by WASO Wildlife and Vegetation staff and a field exercise was conducted at Chickamauga Battlefield, where Bob Warren of U/GA provided interim results of his deer research.

Christine Johnson and Lillian McElrath conducted an overview of the region's exotic vegetation. Rob Sutter of The Nature Conservancy covered I&M techniques, and David Jones, Doug DeVries, and Tony Pernas discussed exotic pest plant councils and a case study. Also covered were various IPM topics, including fire ants, Africanized bees, and hantavirus. A computer lab was devoted to the new WASO resource management plan software and GIS applications.

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Trish Patterson, Program Analyst for the region's Natural Resource Management and Science Office, has been selected for the Women's Executive Leadership Program. This program, for non-supervisory employees at GS levels 11 and 12, is designed to prepare participants for future leadership positions.

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Recently published reports include:

Hammitt, W.E., M.E. Patterson, R.M. Chubb, F.M. Noe, and N. Guse. 1994. Starting a Geographic Information System (GIS) Database for Blue Ridge Parkway. NPS/SERBLRI/NRTR-94-01

Publications of interest:

Davis, S.M., and J.C. Ogden (eds). 1994. "Everglades: The Ecosystem and Its Restoration." St. Lucie Press, Delray Beach, FL.

Mid-Atlantic Region

Under the coordination of Elaine Furbish, Assateague Island National Seashore (NS) successfully conducted two prescribed burns in March 1994, over a total of 200 acres. The burn plan and fire management plan were prepared by Dr. Bill Patterson, U/MA. The purpose was to evaluate the use of fire to maintain native dune grass communities. The protective nature of the dunes has allowed the development of an unnatural shrub community, which is a desirable habitat for the exotic sika deer.

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Colonial National Historical Park is completing work on a Water Resources Management Plan and associated GIS map portfolio. Work is continuing on a groundwater study of adjacent urban impacts. Three-fourths of the sampling has been conducted by the Virginia Institute of Marine Sciences, also a cooperator on the Plan. Locations of all the sampling wells are being entered into the park's GIS. The park also is cooperating with the Virginia Department of Natural Heritage in the preparation of a detailed monitoring and management plan for RTE species; and the Virginia State Geologist is working on a 1:24,000 geological map that will include the park and be GIS-based.

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Results from a 1991 time of travel study on the Delaware River have been published: "Determination of traveltime in the Delaware River, Hancock, New York, to the Delaware Water Gap by use of a conservative dye tracer." 1994 USGS Water-Resources Investigations Report 93-4203.

* * *

An organizational meeting of cooperative researchers involved in the Hemlock Woolly Adelgid project was held March 8 at Delaware Water Gap NRA. Preliminary results from the 1993 season were presented for the hemlock monitoring program, the small mammal and amphibian survey, and the fish population study. Plans for the understory vegetation study were presented and strategies developed to prevent conflict and overlap of simultaneous studies.

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Delaware Water Gap NRA staff attended a Neotropical Migratory Bird Workshop sponsored by New Jersey. The objective of the conference was to inform people of national, regional and state efforts to protect Neotropical birds and their habitat; and to develop a state (NJ) plan to guide protection, monitoring, research, management, and information and education programs.

Conservation Biologists Conduct Study Of Alien Species in Hawaiian Rainforests

By RobinMyers and Christine Schonewald-Cox

We are currently conducting a multi-scale study of the spread of alien species into the native rainforests of windward East Maui. This study involves the National Park Service (NPS), National Biological Survey (NBS), NASA, the Nature Conservancy, and other Hawaiian agencies. Our primary analysis tool will be ARCINFO geographic information system (GIS) software.

We are trying to coordinate our efforts with other local, state, and federal agencies to minimize duplicate efforts and maximize use of the results. Because our work involves evolving standards for aerial photography vegetation classification, inventory and monitoring, GIS data analysis, and meta-data creation, we want to be sure that others involved in similar work are aware of our ongoing study. If you have information on the evolving standards, protocols, and techniques we describe, or if you would like more information on our research, please contact us.

Landscape Transformation Factor

The conservation of biological diversity is an important topic in both resource management and research. Recently ecologists have begun to recognize issues in biological conservation as high priority research topics, including habitat diversity, the conservation of rare and declining species, natural and anthropogenic changes in patterns of species, and the effect of global and regional change on biological diversity. The loss of species, communities, or entire ecosystems frequently is the result of human landscape transformation.

The spread of alien species into native forests is a concern in most island and continental systems. However, most attempts to track and map the spread of alien species have been conducted at the two extremes of study scale: (1) local transect analysis, which is expensive and geographically limited; and (2) satellite imagery analysis, which is difficult to interpret and frequently too coarse-grained to compensate for geographically restricted transects. This study, for the first time, provides an integrative approach for identifying, detecting, and predicting changes related to alien species spread into native forests at both scales, integrated and connected by a meso-scale analysis.

Conservation generally takes place at the landscape or regional level, while ecological research occurs at the species or community level. Our challenge is to integrate the two, while focusing on a middle ground. Integrative multi-disciplinary research is the key to finding practical and biologically defensible solutions to conservation problems. This study provides an integrative approach for identifying, detecting, and predicting changes related to alien species spread into native montane forests--for the first time at both the micro and macro scales, and integrated and connected by a meso-scale analysis.

A Crisis Management Tool

Our primary motivation in this effort is drawn from the crises related to ecosystem changes caused by the introduction of alien species. Our long-term goal is to determine the patterns of alien species spread in such a way that our methods of interpretation can be used throughout Oceania and the Pacific Rim. These islands (Polynesia, Micronesia, Melanesia) are experiencing alien species invasions with concomitant losses of native fauna and flora.

This multi-scale interdisciplinary study is designed with three primary components (Fig. 1). The Macro-scale Component is a coarse-grained landscape analysis of geographic features for the entire watershed; the Meso-scale Component is a medium-grained landscape analysis examining current and historic aerial photographs over time in identified focus areas; and the Micro-scale Component is a fine-grained field verification of landscape features conducted in permanent plots and transects to identify corresponding native and alien species assemblages and indicators of disturbance. Previous research has suggested that the presence and extent of alien species are related to disturbance, whether the result of human land use or natural events.

Our first goal will be to identify the key factors in this relationship. A gap analysis (Scott et al. 1993) of the macro-scale data will be analyzed in the ARCINFO Geographic Information System, comparing agency land use policies with changes in the percent of alien vegetation cover to identify gaps in protection of native forest.

Our second goal is to identify what landscape features and species assemblage information can be detected at each scale. Using a multi-scale approach, we will analyze the abilities and limitations of the three component scales of observation to detect landscape features and patterns.

Our third and final goal is to determine if the presence of alien species assemblages can be detected by specific dominant canopy classes and landscape features using aerial photography and/or remote sensing.

Myers is a PhD candidate in the Graduate Group in Ecology at U/CA Davis, and a cooperative education research scientist trainee in the Ecosystem Science and Technology Branch of the NASA Ames Research Center, Moffett Field, CA. Her dissertation research in East Maui is being conducted with interagency cooperation at the NBS/CSU at Davis. Schonewald-Cox is a research scientist with the NBS/CSU and adjunct professor at U/CA Davis.

Reference

Scott, J.M., B. Csuti, R. Noss, et al. 1993. Gap Analysis - A Geographic Approach to Protection of Biological Diversity. Wildlife Monographs, N123:1-41.

H. Ronald Pulliam Named To Direct NBS

H. Ronald Pulliam, whose research specialities are conservation ecology, ecosystem management, and avian population dynamics, will take over the reins of the newly emerging National Biological Survey--creature of Secretary Babbitt's effort to sharpen and focus scientific research across the board at the Department of the Interior. The NBS mission is to gather, analyze, and disseminate biological information helpful for good stewardship of natural resources.

A native of Miami Beach, FL, Pulliam received his formal training at U/GA (B.S., 1968), Duke University (Ph.D., 1970), and postdoctoral studies at the University of Chicago (1070-71).

Most recently, he was director and professor at the U/GA Institute of Ecology (1987-1994). Under his leadership, the Institute expanded from its research mission to a school at the University, offering a full graduate and undergraduate curriculum. His recent research focus has been on predicting the impact of land use changes on animal population trends.

Pulliam was highly recommended for the appointment to the NBS post by the National Academy of Sciences, which at the request of Secretary Babbitt conducted a nationwide search for qualified candidates. The Academy recently recommended the nomination of the current director for the U.S. Geological Survey, Dr. Gordon Eaton.

Babbitt noted that "We want Americans everywhere to understand and learn more about the health of our nation's resources. The NBS is a tool that will make science more accessible to the public."

Eugene Hester, who guided the NBS through its formation period, will continue at NBS as deputy director.

Information Crossfile

A productive and easy method to discover what animal species are present in a particular parcel of managed land is the conduct of regular road kill surveys. This method is described in ***Resource Management Notes***, Vol. 6 No. 2 p. 4, the Newsletter published by the FL DNR in Tallahassee. As a result of this practice, six "new" species have been added to the Guana River Stte Park's vertebrate list.

Systematic collection of these data can be made during routine patrols of park staff in performance of their regular duties. An impressive vertebrate list can be accumulated in this way in a cost effective manner. Bert Charest, the state park's biologist, points out that rare and highly secretive species can often be added to park lists via road kill surveys.

* * *

On April 21, 1994, Director Kennedy's Bulletin Board contained a memorandum to all NPS employees regarding strategic planning for the Service. Sections on "Creating Our Future," "Our Changing Circumstances," and "Our Symbiotic Roles," were followed by "The Ten Most Important Things We Can Do." Separate sections on these 10 were headed: (1) Lead through exemplary park resource management; (2) Achieve sustainability in park operations and development; (3) Ensure that the NP System reflects our shared national heritage and use the System to help people forge emotional, intellectual, and recreational ties with that heritage; (4) Develop and support heritage education; (5) Move toward ecosystem management; (6) Reorient assistance programs to focus on conservation of entire landscapes and critical open space; (7) Develop NPS leadership; (8) Invest in employees; (9) Create management structure and systems that place organizational resources as close as possible to the sources of value and enhance accountability for results; and (10) Pursue maximum public benefit through partnerships and other forms of entrepreneurial management.

* * *

Craig Shafer, author of ***Nature Reserves: Island Theory and Conservation Practice***, has written an invited chapter entitled "Beyond Park Boundaries" for a forthcoming book, ***Landscape Planning and Ecological Networks***, to be published in 1994 by Elsevier. Focus of the book is on reversing the negative effects of habitat fragmentation.

* * *

R. Gerald Wright, NPS Research Biologist, is one of three authors of an article, "An Ecological Evaluation of Proposed New Conservation Areas in Idaho: Evaluating Proposed Idaho National Parks," appearing in ***Conservation Biology***, Vol. 8, No. 1, pp 207-216. The article deals with four areas that have been proposed by various interest groups as national parks. The four average 220,000 ha and contain important biological, scenic, recreational, and geological resources, but the biological resources that would be protected have received little consideration. Using the USFWS Gap analysis project databases, the authors evaluated the vegetation types contained in each proposal and found the proposals wanting in this regard.

"However," their abstract states, "the protection provided by each proposal could be enhanced ... with the addition of relatively few hectares... Although national parks throughout the world play an important role in the conservation of biodiversity, this attribute is often accidental, and as our analysis showed, more attention needs to be devoted to biological data in the selection and design of new parks."

* * *

An ecological thriller in the making is the once-abandoned and now about-to-be-revived effort to combat *Solenopsis invicta*, the Argentine fire ant accidentally introduced into the U.S. in the early '40s, and seriously threatening insect biodiversity in its seemingly inexorable spread.

The unfinished story is outlined by Charles C. Mann in the March 18, 1994 issue of ***Science*** (pp 1560-61). The ants, which began as territorial "monogynes," have developed a "polygyne" form that creates interconnected "super-colonies" with scores of egg-laying queens. Today they dominate in Texas and may be ready to spread throughout the South... their polygyne form represents "a kind of sheet of fire ants through the earth," according to David F. Williams of the Medical and Veterinary Entomology Research Lab at the USDA Agricultural Research Service in Gainesville, FL. In one research area studied, the number of other ant species fell by 70 percent after the fire ant invasion; the number of arthropod species—insects, spiders, ticks, etc., dropped by 40 percent.

A late 1950s attempt to eliminate the pests, using World War II bombers and the poison mirex, only helped spread the fire ants rather than controlling them, and the effort was abandoned after 1960. However, recent reports that they are actually damaging the environment has given rise to plans for a "rejuvenated" program... one that will not resemble the mirex orgies of the past, but instead will be "a three-legged stool:" occasional use of mirex, educational efforts, and biological control.

Three organisms are being studied—for efficacy and for their effects on non-targeted species. The three most likely candidates for "hero" in this epic are a protozoan parasite, *Thelohania solenopsae*, known in Argentina to kill as many as 2/3 of the *S. invicta* in a colony; a phorid fly in the genus *Pseudateon*, that preys exclusively on fire ants; and *Solenopsis daugerri*, a parasitic ant. Because of its ability to mimic the queen's pheromones, the parasitic ant hornswoggles worker ants into feeding it, rather than the queen they are supposed to be guarding—thus allowing the parasites to "yoke" the queen, who starves to death in full view of the workers who serve her.

Williams says controlling fire ants my be necessary to avert a small-scale catastrophe for insect biodiversity in the South.

* * *

The Desert's Past: A Natural Prehistory of the Great Basin, by Donald K. Grayson (Smithsonian Institution Press, Washington, DC, 1993, 356 pp, $44.95) is reviewed in the March 18, 1994 issue of ***Science*** by David P. Adam of the USGS, Menlo Park, CA. He notes that the book provides a useful overview of the insights gained through analysis of packrat middens and accelerator-mass-spectrometer radiocarbon dating over the past two decades. The remarkably late appearance of single-leaf pinon pine during the Holocene, for example, now is understood far better than it was only a few decades ago. This book brings together the results of a wide variety of investigations in archeology, geology, paleohydrology, climatology, meteorology, biogeography, dendrochronology, and history "to create an engrossing description of the region's changing environment during the past 25,000 years."

* * *

Desperate measures to control the rabbits and foxes introduced to the island of Australia in the mid-1800s are being considered by the Cooperative Research Centre for Biological Control of Verebrate Pest Populations (a government and university consortium), and a chorus of rising concern is greeting the proposal.

Described by Virginia Morell in the August 1993 issue of ***Science*** (pp 683-4), the plan is to release genetically redesigned viruses that will sterilize most foxes and rabbits by tricking the females' immune systems into attacking male sperm.

Mark Bradley, a reproductive immunologist and project leader of the fox program, admits that "No country has ever tried to

manage a pest species on this scale or in this way before. It raises questions across disciplines, from virology to immunology to the animals' social behavior and ecology." Yet it could, if successful and safe, provide a model for wiping out pests in other fragile, threatened habitats such as Hawaii and New Zealand.

During the 110 years of failed control attempts, foxes and rabbits have been implicated in the extinction 20 species of local marsupials.

* * *

Run, do not walk, to find the April 1994 issue of ***BioScience*** (Vol. 44, No. 4). No pages are cited, because the entire issue is jam-packed with articles of interest to NPS scientists and resource managers. Five Special Section articles deal with Hurricane Andrew and its impact on the Everglades: "Hurricane Andrew" by Stuart L. Pimm, Gary E. Davis, et al, assesses damage and considers long-term consequences to well-studied ecosystems; "Hurricane Andrew's Effects on Marine Resources" by James T. Tilmant, Richard W. Curry, Ronald Jones, et al, describes the small underwater impact that contrasts sharply with the destruction in mangrove and upland-forest communities; "Hurricane Impact on Uplands and Freshwater Swamp Forest" by Lloyd Loope, Michael Duever, Alan Herndon, et al, treats large trees and epiphytes, which sustained the greatest hurricane damage; "Hurricane Andrew's Impact on Freshwater Resources" by Charles T. Roman, Nicholas G. Aumen, Joel C. Trexler, et al, finds that water quality--so important to defining the Everglades' unique ecological composition--appears to have been little affected; "Mangroves, Hurricanes, and Lightning Strikes" by Thomas J. Smith III, Michael B. Robblee, Harold R. Wanless, and Thomas W. Doyle, is an assessment of Hurrican Andrew that suggests an interaction across two differing scales of disturbance.

In the same issue, Jeffrey P. Cohn's "Salamanders slip-sliding away or too surreptitious to count?" is an overview of the scientific debate regarding salamander numbers. He notes that Interior Secretary Babbitt announced last November that the USFWS and International Paper had agreed to conserve 4,500 acres of company-owned timberland in Alabama for the Red Hills salamander...listed as threatened in 1976.

Also in this excellent issue is a piece by Raymond E. Grizzle titled "Thinking of Biology: Environmentalism should include human ecological needs." Grizzle's "references" amounts to a literature review of the subject, citing 37 sources including former NPS scientist S.P. Bratton. Grizzle posits that lack of explicit inclusion of human needs in the formulation of environmental protection programs has created problems that are insurmountable at the level of what he terms "the basic world view." Striking a now familiar note of "transcendence" above the current level of struggle, he concludes: "Environmentalism must be expanded to explicitly address human needs."

* * *

A dismal record of success in attempts to reintroduce endangered plants (in "mitigation" efforts) as an easy option in the political and legal frameworks of conservation is exposed in an article by William H. Allen in the February 1994 issue of ***BioScience*** (pp 65-68). Translocation, often in order to allow a development years in the planning "to reconcile the long-term realities of ecology with the short-term imperatives of the economic bottom line") is the most dramatic of the reintroduction techniques "and the one where success is the most uncertain—especially for species that are rare or restricted to rare habitats."

Instead of being treated as something we know how to do with a high degree of confidence, "mitigation" by this means is "surrounded by uncertainty and partial success at best and failure more frequently," according to a quote from Don Falk, executive director of the Society for Ecological Restoration based in Madison, WI. "At its worst," Falk says, "mitigation can be a charade, a fairy tale." He adds: "At its best, it is a healing art of ecology...the art of the possible."

* * *

"A Conceptual Model of Arid Rangeland Degradation" by Suzanne J. Milton, W. Richard J.Dean, et al in the February 1994

Continued on back cover

Dinosaur Blood: Warm or Cold?

The paleontological debate over ectothermy vs. endothermy among the dinosaurs continues to rage within the scientific arena, hotter than the hottest blood proposed by the most ardent endothermy advocates. For an entertaining recap of the battle thus far, see Richard Monastersky's piece in ***Science News***, May 14, 1994, pp.312-313.

Monastersky outlines the history of the debate, quotes the scientists whose names recall the various twists and turns in the evidentiary arguments, and brings us up to date with the recent work by Anusuya Chinsamy of U/PA, who compared the bones of young and old animals from a single species. Her reconstruction of how dinosaurs grew has yielded "a confusing array of results," arising from analyses of the cross sections of femurs from the dinosaur type called *Syntarsus*. She found growth rings, usually indicating temporary stops in bone-building and seeming to link the animal with ectotherms (cold-blooded animals that tend to become dormant in difficult seasons such as wintertime).

But Chinsamy also found evidence that this small predatory dinosaur stopped growing when it reached adulthood—typical of endotherms and not of ectotherms. In addition, the *Syntarsus* bone showed rapid growth, another characteristic of endotherms.

Into this muddy picture has leapt John Ruben, Oregon State University professor of zoology. Ruben contends that the focus has been all wrong—that paleontologists, instead of examining slices of femur, should have been looking up a dinosaur's nose. Endothermic animals have a special set of nasal bones directly related to their metabolism, called maxilloturbinals--bones that form thin, folded sheets inside the nasal passages of birds and mammals and prevent warm-blooded, fast-moving animals from losing too much moisture.

The maxilloturbinals work as a humidifier-dehumidifier system. Willem J. Hillenius, a former student of Ruben's, has traced the evolution of endothermy in mammals by searching for maxilloturbinals or the internal ridges to which they attached. His findings support the idea that endothermy evolved because it enhanced an animal's ability to maintain strenuous activity, and he suggests that this is the most promising avenue to pursue in determining whether dinosaurs had a fast metabolism.

Ruben points out that some modern ectotherms can grow and move rapidly, but they lack the endurance of mammals and birds. "I think in the end," Ruben said, "we're going to find that dinosaurs were probably fairly typical ectotherms, metabolically, but that doeat doesn't mean they were sluggish or uninteresting."

issue of ***BioScience*** details the escalating cost of declining productivity. A four-step model of degradation is presented and analyzed against data from all levels of the arid ecosystems. Shifts in vegetation compositio have been conceptualized to occur either in predictable sequences or unpredictably in response to stochastic events. As degradation progresses, each step may lead to a number of states, and within each state various cyclic successions may occur. At every descending step of rangeland degradation, restoration becomes more costly in terms of loss of secondary productivity and expenditure of energy.

The authors conclude that "Unless rangelands are maintained at the step-one condition by livestock reduction in dry years, productivity will be irreparably lost because further degradation involving changes in secondary productivity, fauna, and soil become too costly to reverse in an overpopulated, resource-starved world."

* * *

Two more articles in the February 1994 ***BioScience*** that are of interest to certain resource managers are "Forest Gaps and Isolated Savanna Trees" by A. Joy Belsky and Charles D. Canham, and "Coevolution of Agroecosystems and Weed Management" by C.M Ghersa, M.L Roush, S.R. Radosevich, and S.M. Cordray. The former, an application of patch dynamics in two ecosystems, concludes that discontinuities alter both the microclimate and the availability of resources crucial to component species. The latter maintains that weed-management practices have become closely linked to social and economic, rather than biological, factors. The key proposed by the authors to finding a way out of the resulting dilemma, lies in minimizing the use of energy and maximizing the use of information.

In both cases, the references cited amount to a virtual survey of the literature.

* * *

To meet the need for a pocket-sized field reference for the wetland plant list, Resource Management Group, Inc., has published the most recent version of the ***National List of Scientific Plant Names*** for Regions 1, 2, 3, 9, and 10. Region 1 is ME, NH, VT, MA, CY, RI, WV, KY, NY, PA, NJ, MD, DE, VA, and OH; Region 2 is NC, SC, GA, FL, TN, AL, MS, LA, and AR; Region 3 (which currently is sold out) is MI, IN, IL, MO, IO, WI, and MN; Region 9 is WA, OR, ID, western MT and western WY; Region 10 is CA.

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